Hon. Spencer F. Baird

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KANSAS CITY

REVIEW OF SCIENCE AND INDUSTRY,

A MONTHLY RECORD OF PROGRESS IN

SCIENCE, MECHANIC ARTS AND LITERATURE.

VOL. VI. MARCH, 1883. NO. 11.

GEOLOGY.

THE ANCIENT MISSISSIPPI AND ITS TRIBUTARIES.[1]

J. W. SPENCER, B. A. SC., PH. D., F.G.S., PROFESSOR OF GEOLOGY IN THE STATE UNIVERSITY OF MISSOURI.

Physical geology is the science which deals with the past changes of the Earth's crust, and the causes which have produced the present geographical features, everywhere seen about us. The subject of the present address must therefore be considered as one of geology rather than of geography, and I propose to trace for you the early history of the great Mississippi River, of which we have only a diminished remnant of the mightiest river that ever flowed over any terrestrial continent.

By way of introduction, I wish you each to look at the map of our great river, with its tributaries as we now see it, draining half of the central portion of the Continent, but which formerly drained, in addition, at least two of our great lakes, and many of the great rivers at the present time emptying into the colder Arctic Sea.

1 This lecture was delivered in the Chapel of the State University, at Columbia, as an inaugural address on January 10, 1883, and illustrated by projections. The author has purposely avoided the very lengthy details of scientific observation, by which the conclusions have been arrived at, relating to the former wonderful condition of the Mississippi, and the subsequent changes to its present form; as a consideration of them would not only cause him to go beyond the allotted time, but might, perhaps, prove tiresome.

Let us go back, in time, to the genesis of our Continent. There was once a time in the history of the Earth, when all the rocks were in a molten condition, and the waters of our great oceans in a state of vapor, surrounding the fiery ball. Space is intensely cold. In course of time the Earth cooled off, and on the cold, solid crust geological agencies began to work. It is now conceded by the most accomplished physicists, that the location of the great continents and seas was determined by the original contraction and cooling of the Earth's crust; though very greatly modified by a long succession of changes, produced by the agencies of "water, air, heat, and cold," through probably a hundred millions of years, until the original rock surface of the Earth has been worked over to a depth of thirty or forty miles.

Like human histories, the events of these long *æons* are divided into periods. The geologist divides the past history of the Earth and its inhabitants into five Great Times; and these again, into ages, periods, epochs and eras.

At the close of the first Great Time—called Archæan—the Continent south of the region of the great lakes, excepting a few islands, was still submerged beneath a shallow sea, and therefore no portion of the Mississippi was yet in existence. At the close of the second great geological Time—the Palæozoic—the American Continent had emerged sufficiently from the ocean bed to permit the flow of the Ohio, and of the Mississippi, above the mouth of the former river, although they were not yet united.

Throughout the third great geological Time—the Mesozoic—these rivers grew in importance, and the lowest portions of the Missouri began to form a tributary of some size. Still the Ohio had not united with the Mississippi, and both of these rivers emptied into an arm of the Mexican Gulf, which then reached to a short distance above what is now their junction.

In point of time, the Ohio is probably older than the Mississippi, but the latter river grew and eventually absorbed the Ohio as a tributary.

In the early part of the fourth great geological Time—the Cœnozoic—nearly the whole continent was above water. Still the Gulf of Mexico covered a considerable portion of the extreme southern States, and one of its bays, extended as far north as the mouth of the Ohio, which had not yet become a tributary of the Mississippi. The Missouri throughout its entire length was at this time a flowing river.

I told you that the Earth's crust had been worked over to a depth of many miles since geological time first commenced. Subsequently, I have referred to the growth of the Continent in different geological periods. All of our continents are being gradually worn down by the action of rains, rills, rivulets and rivers, and being deposited along the sea margins, just as the Mississippi is gradually stretching out into the Gulf, by the deposition of the muds of the delta. This encroachment on the Gulf of Mexico may continue, yea, doubtless will, until that deep body of water shall have been filled up by the remains of the Continent, borne down by the rivers; for the Mississippi alone carries annually 268 cubic miles of mud into the Gulf, according to Humphreys and Abbot. This repre-

sents the Valley of the Mississippi losing one foot off its whole surface, in 6000 years. And were this to continue without any elevation of the land, the Continent would all be buried beneath the sea in a period of about four and a half million years. But, though this wasting is going on, the Continent will not disappear, for the relative positions of the land and water are constantly changing, in some cases the land is undergoing elevation, in others, subsidence. Prof. Hilgard has succeeded in measuring known changes of level, in the lower Mississippi Valley, and records the Continent as having been at least 450 feet higher than at present, (and if we take the coast survey soundings, it seems as if we might substitute 3000 feet as the elevation), and subsequently at more than 450 feet lower, and then the change back to the present elevation.

Let us now study the history of the great river in the last days of the Cœnozoic Time, and early days of the fifth and last great Geological Time, in which we are now living—the Quatenary, or Age of Man—an epoch which I have called *the "Great River Age."*

It is to the condition of the Mississippi during this period and its subsequent changes to its present form that I wish particularly to call your attention. During the Great River Age, we know that the eastern coast of the Continent stood at least 1200 feet higher than at present. The region of the Lower Mississippi was also many hundred feet higher above the sea level than now. Although we have not the figures for knowing the exact elevation of the Upper Mississippi, yet we have the data for knowing that it was very much higher than at the present day.

The Lower Mississippi, from the Gulf to the mouth of the Ohio River, was of enormous size, flowing through a valley with an average width of about fifty miles, though varying from about twenty-five to seventy miles.

In magnitude, we can have some idea, when we observe the size of the lower three or four hundred miles of the Amazon River, which has a width of about fifty miles. But its depth was great, for the waters not only filled a channel now buried to a depth of from three to five hundred feet, but stood at an elevation much higher than the broad bottom lands which now constitute those fertile alluvial flats of the Mississippi Valley, so liable to be overflowed.

From the western side, our great river received three principal tributaries—the Red River of the south, the Washita, and the Arkansas, each flowing in valleys from two to ten miles in width, but now represented only by the depauperated streams meandering from side to side, over the flat bottom lands, generally bounded by bluffs.

The Mississippi from the east received no important tributaries south of the Ohio; such rivers as the Yazoo being purely modern and wandering about in the ancient filled-up valley as does the modern Mississippi itself.

So far we find that the Mississippi below the mouth of the Ohio differed from the modern river in its enormous magnitude and direct course.

From the mouth of the Ohio to that of the Minnesota River, at Fort Snelling, the characteristics of the Mississippi Valley differ entirely from those of the lower sections. It generally varies from two to ten miles in width, and is bounded

almost everywhere by bluffs, which vary in height from 150 to 500 feet, cut through by the entrances of occasional tributaries.

The bottom of the ancient channel is often 100 feet or more below the present river, which wanders about, from side to side, over the "bottom lands" of the old valley, now partly filled with *debris*, brought down by the waters themselves, and deposited since the time when the pitch of the river began to be diminished. There are two places where the river flows over hard rock. These are at the rapids near the mouth of the DesMoines River, and a little farther up, at Rock Island. These portions of the river do not represent the ancient courses, for subsequent to the Great River Age, according to General Warren, the old channels became closed, and the modern river, being deflected, was unable to re-open its old bed.

The Missouri River is now the only important tributary of this section of the Mississippi from the west. Like the western tributaries, farther south, it meanders over broad bottom lands, which in some places reach a width of ten miles or more, bounded by bluffs. During the period of the culmination, it probably discharged nearly as much water as the Upper Mississippi. At that time, there were several other tributaries of no mean size, such as the Des Moines, which filled valleys, one or two miles wide, but now represented only by shrunken streams.

The most interesting portion of our study refers to the ancient eastern tributaries, and the head waters of the great river.

The greater portion of the Ohio River flows over bottom lands, less extensive than those of the west, although bounded by high bluffs. The bed of the ancient valley is now buried to a depth of sometimes a hundred feet or more. However, at Louisville, Ky., the river flows over hard rock, the ancient valley having been filled with river deposits on which that city is built, as shown first by Dr. Newberry, similar to the closing of the old courses of the Mississippi, at Des Moines Rapids and Rock Island. However, the most wonderful changes in the course of the Ohio are farther up the river. Mr. Carll, of Pennsylvania, in 1880, discovered that the Upper Alleghany formerly emptied into Lake Erie, and the following year, I pointed out that not only the Upper Alleghany, but the whole Upper Ohio, formerly emptied into Lake Erie, by the Beaver and Mahoning Valleys (reversed), and the Grand River (of Ohio). Therefore, only that portion of the Ohio River from about the Pennsylvania—Ohio State line, sent its waters to the Mexican Gulf, during the Great River Age.

Other important differences in the river geology of our country were Lake Superior emptying directly into the northern end of Lake Michigan, and Lake Michigan discharging itself, somewhere east of Chicago, into an upper tributary of the Illinois River. Even now, by removing rock to a depth of ten feet, some of the waters of Lake Michigan have been made to flow into the Illinois, which was formerly a vastly greater river than at present, for the ancient valley was from two to ten miles wide, and very deep, though now largely filled with drift.

The study of the Upper Ancient Mississippi is the most important of this ad-

dress. The principal discoveries were made only a few years since, by General G. K. Warren of the Corps of Engineers, U. S. A. At Ft. Snelling, a short distance above St. Paul, the modern Minnesota River empties into the Mississippi, but the ancient condition was the converse. At Ft. Snelling, the valleys form one continuous nearly straight course, about a mile wide, bounded by bluffs 150 feet high. The valley of the Minnesota is large, but the modern river is small. The uppermost valley of the Mississippi enters this common valley at nearly right angles, and is only a quarter of a mile wide and is completely filled by the river. Though this body of water is now the more important, yet in former days it was relatively a small tributary.

The character of the Minnesota Valley is similar to that of the Mississippi below Ft. Snelling, in being bounded by high bluffs and having a width of one or two miles, or more, all the way to the height of land, between Big Stone Lake and Traverse Lake, the former of which drains to the south, from an elevation of 992 feet above the sea, and the latter only half a dozen miles distant (and eight feet higher) empties, by the Red River of the north, into Lake Winnipeg. During freshets, the swamps between these two lakes discharge waters both ways. The valley of the Red River is really the bed of an immense dried-up lake. The lacustrine character of the valley was recognized by early explorers, but all honor to the name of General Warren, who, in observing that the ancient enormous Lake Winnipeg formerly sent its waters southward to the Mexican Gulf, made the most important discovery in fluviatile geology,—a discovery which will cause his name to be honored in the scientific world long after his professional successes have been forgotten.

General Warren considered that the valley of Lake Winnipeg only belonged to the Mississippi since the "Ice Age," and explained the changes of drainage of the great north by the theory of the local elevation of the land. Facts which settle this question have recently been collected in Minnesota State by Mr. Upham, although differently explained by that geologist. However, he did not go far enough back in time, for doubtless the Winnipeg Valley discharged southward before the last days of the "Ice Age," and the great changes in the river courses were not entirely produced by local elevation, but also by the filling of the old water channels with drift deposits and sediments. Throughout the bottom of the Red River Valley a large number of wells have been sunk to great depths, and these show the absence of hard rock to levels below that of Lake Winnipeg; but some portions of the Minnesota River flow over hard rock at levels somewhat higher. Whether the presence of these somewhat higher rocks is due entirely to the local elevation, which we know took place, or to the change in the course of the old river, remains to be seen.

Mr. Upham has also shown that there is a valley connecting the Minnesota River, at Great Bend at Mankato, with the head waters of the Des Moines River, as I predicted to General Warren a few months before his death. At the time when Lake Winnipeg was swollen to its greatest size, extending southward

into Minnesota, as far as Traverse Lake, it had a length of more than 600 miles and a breadth of 250 miles.

Its greatest tributary was the Saskatchewan—a river nearly as large as the Missouri. It flowed in a deep broad cañon now partly filled with drift deposits, in some places, to two hundred feet or more in depth.

Another tributary, but of a little less size, was the Assiniboine, now emptying into the Red River, at the City of Winnipeg. Following up this river, in a westerly direction one passes into the Qu' Appelle Valley,—the upper portion of which is now filled with drift, as first shown by Prof. H. Y. Hind. This portion of the valley is interesting, for through it, before being filled with drift, the south branch of the Saskatchewan River formerly flowed, and constituted an enormous river. But subsequent to the Great River Age, when choked with drift, it sent its waters to the north Saskatchewan as now seen. There were many other changes in the course of the ancient rivers to the north, but I cannot here record them.

As we have seen, the ancient Mississippi and its tributaries were vastly larger rivers than their modern representatives. At the close of the Great River Age, the whole continent subsided to many hundred feet below its present level, or some portions, to even thousands of feet. During this subsidence, the Mississippi States north of the Ozark Mountains formed the bed of an immense lake, into the quiet waters of which were deposited soils washed down by the various rivers from the northwestern and north central States and the northern territories of Canada. These sediments, brought here from the north, constitute the bluff formation of the State, and are the source of the extraordinary fertility of our lands, on which the future greatness of our State depends. However, time will not permit me to enter into the application of the facts, brought forward, to agricultural interests. But although this address is intended to be in the realm of pure science, I cannot refrain from saying a word to our engineering students as to the application of knowledge of river geology to their future work. The subject of river geology is yet in its infancy, and I have known of much money being squandered for want of its knowledge. In one case, I saved a company several thousand dollars, though I should have been willing to have given a good subscription to have seen the work carried out from the scientific point of view.

I will briefly indicate a few interesting points to the engineer. Sometimes in making railway cuttings it is possible to find an adjacent buried valley through which excavations can be made without cutting hard rock. In bridge building especially, in the western country, a knowledge of the buried valleys is of the utmost importance. Again, in sinking for coal do not begin your work from the bed of a valley, unless it be of hard rock, else you may have to go through an indefinite amount of drift and gravel; and once more, in boring for artesian wells, it sometimes happens that good water can be obtained in the loose drift filling these ancient valleys; but when you wish to sink into harder rock, do not select your site of operations on an old buried valley, for the cost of sinking through gravel is greater than through ordinary rock.

In closing, let us consider to what the name Mississippi should be given. In point of antiquity, the Ohio and Upper Mississippi are of about the same age, but since the time when in growing southward they united, the latter river has been the larger. The Missouri River, though longer than the Mississippi is both smaller and geographically newer,—the upper portion much newer.

Above Ft. Snelling, the modern Mississippi, though the larger body of water, should be considered as a tributary to that now called Minnesota, whilst the Minnesota Valley is really a portion of the older Mississippi Valley—both together forming the parent river, which when swollen to the greatest volume, had the Saskatchewan River for a tributary, and formed the grandest and mightiest river of which we have any record.

GEOLOGICAL SURVEY OF MISSOURI.

PROF. S. H. TROWBRIDGE.

A bill has been introduced by Senator Britts, in the Upper House of the State Legislature now in session, to provide for the resurrection of the geological survey of our State. It is a measure that merits the approval and best efforts in its behalf of every citizen interested in the prosperity of one of the richest States in natural resources in the Union. On this account, there is perhaps no other State that would receive equal benefit from a complete and thorough survey of the natural wealth within her borders.

The first State Geologist was Prof. G. C. Swallow, who held the office from 1853 to 1861. Of the work done during this time, only that embodied in two bound volumes has been published by the State, though some still remains in manuscript form. The first volume contains the "First and Second Annual Reports" and was published in 1855. These reports were based upon information gained during a hasty reconnoissance lasting about eighteen months. The first was simply a report of progress four pages long. The second was in two parts, of 207 and 239 pages, and gave a brief discussion of the general geology of the State, reports of five counties, and a report on the then most important mineral resources. From the time of publication of this first volume to the discontinuance of the survey in 1861, twenty-one additional counties were surveyed by G. C. Broadhead, B. F. Shumard, and F. B. Meek. These counties are scattered somewhat promiscuously through the State, fifteen south of the Missouri River and six north, and none very near the western border. The second bound volume containing reports of these counties was printed in 1873. It contains 323 pages.

From 1861 to 1870 the survey was entirely inactive. At the latter date the Legislature organized a "Bureau of Geology and Mines," which had power to appoint a State Geologist. This Board appointed Prof. Albert D. Hager, from Vermont, who served one year, and published a report of progress of no special

value. After Prof. Hager, Dr. Norwood had temporary charge of the survey till Prof. Raphael Pumpelly was appointed, in the latter part of 1871. He entered upon his duties in the spring of the following year, and during this year the material for his report, forming the third bound volume, was collected. This report was an octavo, published in 1873 by Julius Bien, of New York. The volume is divided into two parts; the first, of 214 pages, devoted to the great iron interests of the State; the second, 441 pages, discusses the perhaps equally great coal interests. Most of this was the work of Mr. Broadhead. The work is accompanied with a large atlas. Under Mr. Pumpelly, eight counties were surveyed. On his resignation in the summer of 1873, G. C. Broadhead was unanimously appointed State Geologist. He, with the assistance of Mr. C. J. Nowood, surveyed fifteen additional counties, and published in 1874 a report of about 800 pages with numerous figures and a series of maps. Dr. Adolph Schmidt, who was at one time director of iron works in Europe, and afterward in charge of extensive Bessemer steel works, gave great attention to the iron ores of the State during the last two administrations. Many other assistants were employed from time to time on the survey. Owing to mistaken notions of economy, the Legislature of 1874 voted to discontinue the survey and turn over its property, collections, etc., to the State School of Mines at Rolla. From that time to the present nothing has been done.

Without entering at all into the details of the work thus far accomplished, and without even noting some *general* results of more or less value, we find that less than half of the counties have been examined, and even these, through no fault of the geologists in charge or their assistants, have not been examined at all exhaustively. Enough has been done, however, to show that the State is remarkably rich in all those natural products which contribute most largely to her material prosperity. What is now imperatively needed is to have this vast wealth so thoroughly investigated, presented in correct and intelligible form, and given to the world, that it shall afford the much needed assistance to her own citizens, and shall attract the large immigration to her soil which she can so bounteously support. Individuals and corporations have expended much in private surveys for their own special purposes, and immigration societies and local associations have published, with more or less fulness and accuracy, representations of the peculiar attractions in certain sections. These, however, are necessarily limited and fragmental, and are often highly colored to meet the ends each party has in view.

An impartial, comprehensive, and thorough showing of the State's resources can be had only by disinterested and competent geologists, conscious of their responsibility to the public and true to the interests of science. To such a source explorers will confidently look for facts regarding the wealth which the earth possesses; and the settler will there find a satisfactory exhibit of the natural wealth of his future home, and, by the use of these revelations of scientific research, he can study beforehand the country, select, bound, and parcel his claim, locate his buildings, and carry with him an accurate picture of it all. For this purpose much attention should be given to the construction of topographical maps of

the territory surveyed. This is also necessary to enable the geologist to describe the exact position of any valuable deposit beneath the soil, and for the land-owner to know just where on his farm to search for it. This necessity can be largely obviated in Missouri, for any special and local deposit, by giving its position with reference to range and section lines; but for valuable deposits in strata at a certain level, on all farms, verbal description is totally inadequate. Even if the facts have been observed with the greatest accuracy, they will lose much of their value to the individual owner because the descriptions cannot specify the exact locality for him. He may easily be misled into vast expenditure in search of some mineral in a stratum not present within his limits, though perhaps abundant all about him.

The position of strata, upon which all geological information is based, is determined largely by a study of the fossils they contain. To make this work intelligible to the public, these fossil forms must be correctly described and clearly figured, so that one with sufficient skill may examine the rocks on his own farm and see, by comparison, whether the beds of coal, lead, zinc, etc., described in the State reports, are likely to be found within his limits or are not. For this purpose the figures of fossils are of far greater value to the uninitiated than verbal descriptions; and it requires considerable acuteness of observation to notice, even in these, slight differences in form or marking which may indicate widely different strata, and may easily and greatly mislead an unskilled observer. The collection, examination, and classification of fossils in the rocky strata form a large large part of the geologist's work. While much of this work has been done in the State, it has been scattered and fragmentary, and there is great need of a systematic and thorough revision of it all, and especial need of its publication in a compact and easily accessible form. The publications under State authority present a very meager showing of the fossils and their instructive teachings within our limits. In all the State surveys thus far published, there are only three palæontological plates, and these illustrate but forty-five species. These are in Swallow's report, published nearly thirty years ago.

Other fossils of the State are described and figured in the Transactions of the St. Louis Academy of Science, in geological reports of neighboring States, and elsewhere at private expense, and still others are described but not figured in reports of certain railroad and other corporations. But the State herself should publish, with well executed figures, a full series of the fossils characteristic of the various rock horizons to be found here, many of which have never been described. Illinois has a most excellent exhibit of her fossils in her six volumes of Geological Reports, which are of great benefit and credit to the State and of immense value to science. Iowa, too, another of our nearest neighbors, is far ahead of Missouri, though much behind Illinois. Missouri, with natural resources, doubtless surpassing either or both of these States, should not be overshadowed for the simple lack of making a published showing of her own vast and rich possessions.

Another work much needed in the State is an exhaustive investigation of her

archæological remains. In these Missouri possesses remarkable wealth and presents a most attractive and profitable field of research. Much of this wealth has already gone to enrich eastern museums, which would have remained here had its value been properly appreciated, and much more, doubtless, has been lost or destroyed for the same reason. Traces of our pre-historic inhabitants are rapidly disappearing under the destructive agencies of the plow and other implements of modern civilization; and unless the State takes speedy action in the matter and places upon permanent record the descriptions and exact localities of these ancient remains, they will be lost beyond recovery. Every clue to the history of the former occupants of our soil is daily increasing in value and interest, and Missouri has a rare opportunity of advancing her own credit by contributing what she can to the settlement of these important scientific questions. The archæological Section of the St. Louis Academy of Sciences is doing a most valuable work in this direction, and members of the Kansas City Academy are also hard at work, as well as many private parties elsewhere. But the State, with a liberality which would do her immense credit, has far the best opportunity to place upon record a complete history of these ancient works, and this should be embraced before it is forever too late.

The surface geology of the State, too, presents an inviting and profitable field of scientific investigation. The results of glacial action and drift agencies have received far less attention than their importance demands. The bluff or loess deposits are greatly in need of thorough study. In the first place, the different kinds of soils need to be subjected to exhaustive chemical analysis to show what crops can be grown to best advantage upon each, and what ingredients need to be supplied in the form of fertilizers. Secondly, the study of these surface deposits is attracting increased attention from geologists of the adjoining States, and the gap which has thus far existed in Missouri should be filled by careful examinations here to give completeness to the scientific work going on elsewhere in the Mississippi Valley.

Among other excellent features of the bill now before the Legislature, stands prominently the section requiring that suits of specimens of minerals, ores, rocks, fossils, etc., representing the wealth of the State, be furnished, on easy terms, to the colleges and public museums of the State. This is an important move in the right direction, and should of itself insure its passage. Our school instruction, of all grades, at the present time is notoriously deficient in facilities and studies capable of fitting students for *practical life*. This accounts for the facts that "the ratio of school graduates to our population is continually decreasing," and that "men withdraw their sons from the schools when they deem it time to teach them the practical arts and duties of life." Such collections in the colleges of the State, if properly used by teacher and pupils, would go far toward giving the sons of farmers and others a knowledge of practical science which would result in a great saving of useless expense, and be a rich source of revenue to individuals and the State.

The knowledge thus acquired would enable the son of many a land-owner to

see the danger of the *little wisdom* which led his father to spend his living vain attempt to obtain various precious minerals from deposits which the additional knowledge he has gained assures him are utterly worthless. It would protect him from the well meant but financially ruinous zeal of his father in mining for coal, lead, ochres, and other ores, on the unsafe supposition that, because a neighbor in the valley below him finds these in abundance, he will have equal success by sinking a shaft to the same level. His interest in geology, excited by the tangible illustrations his school furnishes for study, would enable him to see, by a brief survey of the rocky strata which he can easily make, that the rocks which his neighbor finds so productive dip away from him, or, by an upward curvature of the earth's crust which formed the elevation on which he stands, the wealth-bearing stratum was exposed on the surface to the action of frost and flood, and has been completely washed away. It would enable him also to avoid the useless expenditures of his father in boring for a bed of coal, even in a region of coal, away down into rock-layers in or below which coal never was and never will be found; and to show his father, from a simple examination of the kinds and position of the strata beneath, that it would be useless to even start his drill in the desired place in search of water. Such practical information as this, so easily gained by any intelligent teacher or pupil when the proper opportunities are afforded, would be of inestimable advantage to mining and farming interests.

The popular impression, too, which this practical education would create, of the value of scientific information in ordinary life, would go far toward securing more intelligent legislation on other points most intimately connected with our material prosperity. Every farmer can make an estimate for himself of the value of the crops annually destroyed by the ravages of insects throughout the State. The most charitable estimate could not fall short of many millions of dollars. Our former State Entomologist agrees with others that in one year Illinois alone lost at least $73,000,000 from the destruction of corn and wheat by the chinch-bug. "Bugologists" variously estimate that from one-tenth to one-half of the $300,000,000 annually destroyed in the United States might and should be saved. The amount thus saved, if devoted to missionary enterprise, would soon convert the world. What should be saved each year in Missouri alone would furnish an income of seven per cent on all the real estate within her borders, or an average annual income of $200 on every farm from one of three acres up. It would build every year as much railroad for carrying agricultural products as would reach twice the length of the State. A live farmer of Howard County told me some years since, from his own standpoint and not from the scientific, that C. V. Riley, while State Entomologist of Missouri, saved the farmers of his own and adjoining counties $50,000 by a single item of advice concerning a single destructive insect. Yet the State lost his services, prized everywhere else, in their wise! and economical!! purpose to save $3,000. If we are losing at this rate by stopping of the entomological survey, it is sincerely to be hoped that we may make what amends we can by re-establishing the Geological Survey.

For every reason that could be urged, it is emphatically desirable that all

friends of the State and its prosperity, of science, of education and of popular enlightenment, will exert their influence to secure the adoption of the pending bill and a vigorous prosecution of the important work it proposes.

THE BOTTOM OF THE OCEAN.

In the National Academy of Sciences, yesterday, in Columbia College, Prof. A. E. Verrill, of Yale College, described the physical and geological character of the bottom of the sea off our coast, especially that which lies beneath the Gulf stream. He made 1,500 observations this summer for the United States Fish Commissioners. He has cruised from Labrador to Chesapeake Bay and about 200 miles out to sea. About sixty miles outside of Nantucket is a streak of very cold water, and animals dredged up are like those caught in Greenland, Spitzbergen, and Siberia. The water is fifty fathoms deep, and the bottom of the ocean is of clay. Boulders weighing eight hundred or one thousand pounds are dredged up. Prof. Verrill believes that they are brought down by icebergs from the Arctic regions and dropped when the ice melts. The boulders are found as far south as Long Island. Further out to sea, seventy to one hundred and twenty miles south from the southeastern coast of New England, the bottom of the sea, which has inclined very gradually eastward, forming a table land, takes a sudden dip downward, so that whereas the water on the edge of the bluff is 100 fathoms deep, at the bottom of the basin it is 1,000 fathoms deep. The slope is as high and as steep as Mount Washington, and on its summit, which is level, a diver, could he go to so low a depth, could not put out his hand without touching a living creature. The bottom of the sea is covered just there with a fauna which has never been before found outside of the Mediterranean Sea, the Gulf of Mexico, the Indies and other tropical regions.

The number of species of fish dredged up is 800, and over half of them have never before been seen by naturalists. Seventy kinds of fish, ninety of crustacea and 270 mollusks have been added to the fauna. The age of many of the specimens shows that they must be permanent in that region. The trawl let down from the ships by a mile of rope brings up a ton of living and dead crabs, shrimp, star fish, and as the trawl simply scrapes over a small surface the ocean bed is plainly carpeted with creatures.

Sharks are seen by thousands in this region, and countless dolphins, but it seems strange that not a fish-bone is ever dredged up. A piece of wood may be dredged up once a year, but it is honeycombed by the boring shell fish, and falls to pieces at the touch of the hand. This shows what destruction is constantly going on in these depths. If a ship sinks at sea with all on board it would be eaten up by fish with the exception of the metal, and that would corrode and disappear. Not a bone of a human body would remain after a few days. It is a constant display of the law of the survival of the fittest. Nothing made by the hand of man was dredged up after cruising for months in the track of ocean ves-

sels excepting coal clinkers shoved overboard from steamships. Here Prof. Verrill corrected himself. Twenty five miles from land he dredged up an India rubber doll. That, he said, was one thing the fish could not eat.

Here the Gulf stream is forty miles further west than any map shows, Prof. Verrill continued; and this stream of warm water from the south nourishes the tropical life near Massachusetts. The temperature further in shore is 35° in August, on the edge of the submarine Mount Washington 52°, and toward the bottom of the basin 39°, while further out to sea the temperature of the water grows colder. On the surface the jelly fish, nautilus and the Portuguese man-of-war, with other tropical fish, are found. In this belt the tile fish, about which so much was said a year ago, were found in immense quantities, but this summer, although expeditions have been made for the express purpose of catching some, not one could be taken. Undoubtedly they had been killed, to a fish, by a storm which carried the cold water into the gulf stream; indeed, it is known that a cold current of water resting on the ocean's bed may contain Arctic fish, and a current of warm water floating over it on the surface may be alive with tropical fish.

As to the quantity of light at the bottom of the sea there has been much dispute. Animals dredged from below 700 fathoms either have no eyes, or faint indications of them, or else their eyes are very large and protruding. Crabs' eyes are four or five times as large as those of a crab from surface water, which shows that the light is feeble, and that eyes to be of any use must be very large and sensitive. Another strange thing is that where the creatures in those lower depths have any color, it is of orange red, or reddish orange. Sea anemones, corals, shrimp and crabs have this brilliant color. Sometimes it is pure red or scarlet—in many specimens it inclines toward purple. Not a green or blue fish is found. The orange red is the fish's protection, for the bluish-green light in the bottom of the ocean makes the orange or red fish appear of a neutral tint and hides it from enemies. Many animals are black, others neutral in color. Some fish are provided with boring tails, so that they can burrow in the mud. Finally, the surface of the submarine mountain is covered with shells, like an ordinary sea beach, showing that it is the eating-house of vast schools of carnivorous animals. A codfish takes a whole oyster into its mouth, cracks the shells, digests the meat and spits out the rest. Crabs crack the shells and suck out the meat. In this way come whole mounds of shells that are dredged up.—*N. Y. Sun.*

ANTHROPOLOGY.

THE KINDRED OF MAN.

ARTHUR ERWIN BROWN.

Mr. A. R. Wallace once called attention to the similarity in color existing between the orang and chimpanzee and the human natives of their respective countries. It would indeed seem as if but half the truth had been told, and that the comparison might be carried also into the region of mind; the quick, vivacious chimpanzee partaking of the mercurial disposition of negro races, while the apathetic, slow orang would pass for a disciple of the sullen fatalism of the Malay. Such, at least, was the impression left by careful observation of several specimens of each species which have been exhibited in the Philadelphia Zoölogical Garden.

A curious study are the moral qualities of the chimpanzee—for he has morals—not altogether such as would serve for the ordering of a human community, but very well adapted, seemingly, for his own needs. Watching them closely, in all their moods, all their passions, it was impossible to avoid the feeling that here was man in his primitive stage of moral development—"nature's ground plan" only—self-love predominant, the brute mainly, with but an occasional flash of the possibilities which the hand of nature was yet to shape.

"Adam" and "Eve" were both young, probably not more than three or four years old, and not half grown, as the chimpanzee is believed to require some twelve or fifteen years for the completion of that stage of existence. They were about the same size—perhaps they were twins—they had no family Bible to settle the question, but the extraordinary likeness between them was strongly in favor of the supposition; indeed, if Adam had not been ornamented with a black smudge across the nose, they could hardly have been told apart; but twins or not, they loved each other with a most devoted affection, or, at least, so it seemed, but subsequent events cast a doubt on the real depth of their feelings.

Being young they were eminently social, for it may be said that as a rule, among wild animals, moroseness and ferocity come only with age. When they were first coaxed out of their traveling cage they were visibly embarrassed, and retired into the nearest corner, locked tightly in each other's arms, which, as we afterwards learned, was a universal refuge in time of doubt, but it was not long before they began to feel at home, and thenceforward were always ready to make friends with anybody who made his approaches in due form. As has been said, they were very fond of each other, and it was on rare occasions only that

they were not clasped in a fond embrace, and not once during their life in the garden was anything but the most perfect accord manifested between them. No pretence of partiality in feeding, no petting of one to the exclusion of the other, could excite a trace of jealousy; the slighted one would simply retire to a corner and sulk, but their mutual relations were undisturbed; resentment was all towards the giver, not to the one who received. Each was at all times ready to stand by the other; probably the keeper has not forgotten the ferocious assault Eve once made on him from the rear, while he was engaged in pouring a dose of medicine down the throat of her companion.

Their anger was something ludicrous; the male especially was liable to paroxysms of rage, during which he would tear his hair with both hands, hurl himself down on the floor with a perfect tempest of yells and roars, but in a moment it was all over, and he was ready to make peace and accept any small attention by way of *amende*. But his masculinity asserted itself more particularly when danger seemed to threaten—then he was grand; advancing inch by inch, brandishing his arms, stopping after each step, with a stern frown, to emit a terrifying roar, he seemed an impersonation of resolution and defiance—a very Ajax—but after all, he was only a Thersites, a more arrant little coward than he, at heart, had never lived, and if his appearance did not have the desired effect, if the intruder stood his ground, the dignified approach gradually became slower, the resolution ebbed away and the inevitable end was a final stop, a hasty turn and an ignominious flight into the corner—generally, it is painful to say, behind Eve. We could only blush, we dared not blame him; one nearer to us far than he, his namesake, under circumstances which brings the action home to each of us, had done the same.

Many experiments were made to test the mental capacity of these animals, with quite fruitful results; the primary mental operations, and even some which involved a greater or less combination of ideas, were performed by them with facility; indeed, it may be doubted if the undirected efforts of a human child of the same age, ignorant of language, could produce results of a much higher grade.

A mirror being placed in the cage, the male, after cautiously investigating the figure reflected, turned it over, and finding nothing but bare boards, he placed it face downward on the floor and executed a sort of war dance on the back. Having repeated this a number of times, the glass was firmly held before him; he then gave it more attention, at first attempting to drive away the figure he saw; at last a resemblance seemed to strike him, and after performing a variety of antics, seemingly for the purpose of comparison, it was quite evident that he became aware of his own identity—and in this, perhaps, afforded a trace of that self-consciousness which conservative philosophy allows only to the lordly intellect of man. In this case it is probable that he had become accustomed to see a faint image of himself reflected from the glass front of his cage.

Perhaps, though, the most striking evidence of their power of reasoning was given when a dead snake was taken into the room and shown to them. As is

well known, monkeys have an intolerable dread of snakes, and these were terrified beyond measure. They fled at once to the highest point of the cage, uttering their expressive cry of fear, and there they remained for hours, refusing to come down even at sight of their accustomed dish of food, and when at last they did so, it was with the greatest caution; a slight movement in the straw covering the floor, was enough to cause a panic, and it was some hours before they fully recovered equilibrium. Finally, when both were sitting quietly near the glass front, the snake was suddenly shown to them on the outside, but there, the object which had caused such terror in the same room, was powerless; the glass which they themselves could not pass, was a barrier as well to their enemy, and they simply sat still, pointing at it with their fingers and uttering the *hoo-hoo* which expressed doubt, dislike and disgust. It was suspected that they had only become accustomed to the sight, and to complete the experiment the snake was again thrown in through the back door, when the terror of the two animals was as great as on the previous occasion.

It was quite clear that they possessed a limited means of vocal communication. Sounds, to the number of three or four, were uttered by one, which met with a different response from the other, either by voice or action, and in which it was quite possible for the human ear to detect a difference.

The imitative habits common to the whole tribe of monkeys were strongly marked in them, and made it relatively easy to teach them to use a spoon or drink out of a cup, and to perform various small tricks. In cleaning the glass in front of the cage with paper, the keeper generally threw two pieces on the floor beside him, when each chimpanzee would take one of them and set to work polishing the glass in like manner, deriving, apparently, great satisfaction from the performance. The delicacy of their taste became developed to an extraordinary degree by the varied diet afforded them; both were fond of the taste of sherry, which was always put in their tapioca and corn-starch, but when brandy, whisky and rum were substituted, they stuck out their under lip in disgust and refused to eat it.

For music they had no ear whatever; the notes of an accordeon and violin produced in them only distrust of the instrument, and when these were put into their hands, their insatiable curiosity prompted only efforts to find out what was inside.

For many months Adam and Eve were the pets of the "Zoo"; few days there were when they were not surrounded by a crowd of interested spectators, some of whom, to a critical eye, were fully as amusing as the animals they came to see.

It is learned from African travelers that the native tribes inhabiting the range of the gorilla and chimpanzee believe them to be human beings who have degenerated from their original state, and that out of pure laziness they refuse to speak, in the fear that if their possession of the faculty should become known, they will be set to work in the fields; indeed, the native name of the chimpanzee, *Enge-e-co*, means "hold your tongue," and evidently originated in this belief. It frequent-

ly seemed as if similar ideas prevailed among a certain part of the visitors, and that class especially whose acquaintance with the forms of orthography had not reached a familiar stage, seemed to find in the scientific name of the animal, *Anthropopithecus niger*, indications of a relationship to the humble man and brother whose ancestors sprang from the same soil.

But at last, in spite of tender care and attention, Eve became sick—poor little thing, how she did suffer. Of course she ought to have been a good and grateful patient and have known that everything done for her was for her ultimate benefit—they always do in the animal literature of the day—but she had read little, and so was hardly to blame in following out the instincts of her nature. She might have been expected to look appealingly into the eyes that bent over her, but she did not; she ought to have pressed affectionately the hand that cut the hair from off the region of her little stomach and gently applied a mustard plaster to the affected part, but instead, she bit it savagely; and to crown all, she was so little sensible of the soothing influence of that mustard plaster that it took the united efforts of three men to keep it in place until its work was done.

Alas for all the works of fancy! a long experience of sick and suffering animals compels the conclusion that one of the things which is beyond the grasp of mind to be found among the lower animals is surgery.

And so Eve passed out from the familiar places of the "Zoo." Her funeral urn stands ranged on a shelf in that universal mausoleum of nature, the Academy of Natural Sciences, and her "In Memoriam," by Professor Chapman, was published in the Proceedings of that venerable institution.

Adam was left alone to mourn, but to his shame be it said that although he was inconsolable at first, so long as the dead body of his late companion was in sight, he soon got over it, and in forty-eight hours not a trace of her seemed to exist in memory, excepting that to the day of his death, some months later, he was afraid to sleep alone on the floor, where the two had always slept together, and with the shades of night he followed out his ancestral habit, climbed as high as he could get toward the roof, and there composed himself to peaceful slumbers.

For some time the garden was without any specimen of the higher apes, until in the autumn of 1879, a young orang-utan was safely received.

There is something about the orang that irresistibly suggests a spider—one of those red, hairy, long-legged spiders which one sees with an instinctive feeling of repulsion. At no age can the animal be called handsome, and the old males, covered with coarse, reddish-brown hair six or eight inches long, with a huge protruding jaw and a mass of hardened skin on each cheek, are about as unprepossessing as anything that nature has produced. "Topsey," however, as is sufficiently indicated by her baptismal name, belongs to the fairer sex; her age —probably for that reason, is unknown. When she arrived she was supposed to be about two or three years old, but as the lapse of time has made hardly any change in her personal appearance, save in the way of *embonpoint*, it is probable that she was older, although she is certainly not half grown; if, indeed, as has

been suggested, she may not be a dwarf—a sort of feminine Tom Thumb among orangs; and in this, possibly is the explanation of the unusually good health which she has enjoyed through a lifetime much longer than is common to her species in captivity. The amount of nutrition required to simply maintain the existing condition of body, would of course be less than if the processes of growth were in full activity, and the assimilation of food, which is probably defective in most caged animals, would, as has been the case here, be sufficient to keep her in good condition.

Between the orang and chimpanzee there is a marked difference in moral qualities. The latter is full of life, vigor, vivacity; lively and child like in disposition, enjoying life to the full, and taking interest in all that goes on about it. Quite the reverse with the orang—it is slow, sluggish and calculating; philosophically indifferent to everything but its immediate wants—voluptuary and stoic in one—life is only for the means of living, and life itself is hardly worth the pain of an exertion. It is exasperating—the apathy of the orang; for hours it will lie wrapped in a blanket close to the front of the cage, lazily following with its eyes the motions of any person within its range of vision, or slowly blinking at a straggling fly upon the glass, moving—when it must move—only with the greatest deliberation. If left hanging by one hand to a rope or branch, there it will hang, perhaps for several minutes, before making up its mind to take hold with the other or let go altogether. Laterly the contrast in the disposition of the animals has been made very striking by the presence in one cage of specimens of each species. A second pair of chimpanzees, about the same size as the orang, were placed with her, and with their natural liveliness at once made overtures of acquaintance, which were as promptly repulsed, and during the first week she suffered so much fright and uneasiness from their perfectly good-natured attempts to induce her to join in their play, that it became necessary to partition off with wire screens a corner of the apartment, and there, hour after hour, while the two chimpanzees are climbing, swinging and tumbling about the cage, never at rest except to plan some new scheme of amusement, the orang lies flat on her back, fingers and toes closely interlocked in the air, enjoying a *dolce far niente*, the relish of which she seems to intensify by quiet wonder at the reckless prodigality of force indulged in by her neighbors.

This stolidity is characteristic of the species in a wild state; there they live mostly in the tree tops, cautiously crawling from branch to branch, testing every limb before resting their weight upon it, moving only to satisfy the demands of hunger, and when that stimulus to action ceases, subsiding into a half-sitting position with the trunk or branch of a tree to hold up the back, head bowed on the breast, hands hanging down—not asleep—it can be nothing but laborious thought that produces such perfect bodily repose. Who can tell how deeply the meditative orang has penetrated into the mysteries of the cosmogony of which he is a part? how many systems of philosophy have dawned, after hours of reflection, into his weary brain? how deeply he has pondered on the origin and destiny of

his race, and to how many metaphysical final causes has his speculative career traced its way?

The orang is really not so stupid as appearances would have it, and it is an interesting fact that the actions of the one in question once gave evidence—and the only evidence the writer has ever observed among the lower animals—of what seemed to be some understanding of death. Another orang had been procured as a mate, and arrived in bad health; it was exceedingly irritable, and though weak from disease, managed to appropriate the only blanket in the cage, and fought off the rightful proprietor whenever she approached. This, with other grievances, caused Topsey to regard the intruder with marked dislike and fear. She watched it from a distance all through the several days of illness, and the more attentively as the last moments drew near and pain and weakness were showing plainly their ravages, until finally, after a hard struggle, the little sufferer lay motionless and dead, then, for the first time, she drew near, looked at the body for a moment, pushed it with one hand, and then after putting her nose close down against its face, as if to listen for a breath or any sign of life, she began pulling from under it the coveted blanket which it was no longer able to defend, and in the most satisfied manner wrapped herself up and laid down in peace.

Much less opportunity has been afforded for critical observation of the remaining anthropoids—the gorilla and the gibbons—as few of either have been kept in captivity; but the former may fairly be considered as not presenting marked mental differences from the chimpanzee, and the latter seem in all respects to be below the level of the others.

In considering the proper station of man and these animals in the zoölogical system, a brief glance must be given at the other members of the order to which they belong.

Three remaining families complete the group of Primates: the Catarrhini, embracing all the monkeys of Africa and Asia, and the Platyrhini, inhabiting tropical America and the West Indies. Besides these are usually included in the order, the Lemurini, a large and ill-assorted group known also as Prosimiæ or half-apes, all of which fundamentally are of the monkey type of structure, but many forms of which partake also in the characters distinctive of bats, rodents and insectivores. The two groups of old and new world monkeys are very well distinguished by anatomical peculiarities; thus in the Platyrhine group the nostrils are far apart and look almost directly forward; there are no cheek pouches for the stowing away of food, nor any of the brightly colored callosities on the haunches, which are common to many of the others; all the American monkeys have long tails, which in many species are strongly prehensile and serve almost the purpose of a hand, while in all of Africa and Asia not a prehensile-tailed monkey is known, and a number of species, including the higher apes, have no tails at all; in this group, too, the nostrils are close together and look downward. The number and arrangement of teeth correspond to that of man, while the greater part of American monkeys have two more teeth in each jaw, and in those which do possess the same number the arrangement is unlike. Geographically

and structurally the apes we have been describing belong to the old-world group, and geographically and structurally, too, man's alliances make it necessary to consider him a member of the same family.

But though it is assuredly no part of the writer's purpose to belittle the evidences of this genetic connection, the candid acknowledgment must be made, that a somewhat undue prominence has been given to the anthropoid apes in this respect—although probably more in popular misconception of what men of science have written than in anything which the writers themselves have intended to convey.

The points of resemblance are many and close, but the category contains many in which each ape stands closer to man than do any of the others, and there are as many more, perhaps, in which similarity is found, not among the higher, but in some of the lowest of the monkey tribe.

A full list of the points of close alliance would be far longer than the purpose of this paper demands, and it will be sufficient to mention a few cases of resemblance and of difference, simply to indicate the complex nature of the relationship.

The gorilla resembles man most in actual bulk, in size of the brain, in proportional length of the hand, and of the thumb and great toe to the spine, of the two segments of the arm to each other, and in the presence of the transversus pedis muscle; but he has no flexor longus pollicis in the hand, no plantaris and no flexor accessorius in the foot, both of which are found in man and most of the lower monkeys.

The chimpanzee is man-like in shortness of arms compared with the spine and with the leg, in many details of brain structure and in the possession of a palmaris longus muscle, but the plantaris, the transversus pedis, and sometimes the flexor accessorius are absent, and the flexor longus pollicis is variable.

The orang excels in the proportion of hand to foot, in some details of the pelvis, and in general brain development is, perhaps, higher than either of the others; it also has the palmaris longus and a part only of the flexor accessorius, but the flexor longus pollicis, the plantaris and transversus pedis are absent, and the flexor longus hallucis belies its name by giving no tendon to the great toe.

In the form of larynx, one of the gibbons comes quite near man, but in other respects is less like him than the other apes.

The chimpanzee and gorilla, like man, have eight bones in the wrist and ankle, while the orang has one additional in each; the human number of twelve ribs is found only in the orang, but to more than offset this, it has in the foot a special muscle, the opponens hallucis, making of the big toe almost a thumb, and of the foot almost a hand—a degraded structure which is not known in any other monkey nor in man.

A close approach to the human form of teeth is found in the anthropoids, but for the reduced size of the canines, the absence of a space both in front and behind each canine, and in some details of the grinding surfaces of the molars, a

parallel is found only in some South American monkeys and in one of the lowly organized lemurs.

The orang and gorilla have the same number of spinal vertebræ as man, but in the curves of the backbone which they form, and which are vitally important to his habitual attitude, the baboons bear a closer resemblance. So, too, with the position of the occipital foramen in the base of the skull, enabling the head to preserve a balance on the vertebral column—a necessary condition of an upright posture—and in the cranio-facial angle, a similar gap between man and the anthropoids, with a closer approximation on the part of some of the lower forms, may be traced.

Owing to the articulations of the tarsal bones, no animal but man can habitually walk erect, and the apes can approach such a position only with the help of some external support; the gorilla, chimpanzee and orang all walk by touching the ends of the fingers or the knuckles on the ground, and in the gibbons the arms are so long that the animal swings itself between them as on a pair of crutches. Some of the South American monkeys, however, notably those of the genus Ateles, are able to walk erect on the hinder extremities for a considerable distance, the long tail serving, to some extent, to preserve the balance.

It has been asserted and maintained by a number of European anatomists, against the venerable authority of Professor Owen, that in the anthropoid brain, the backward projection of the posterior lobes of the cerebrum overlap and completely hide the cerebellum from view, when looked at from above, as is the case in man—an almost steady progression from the lowest types of brain towards this arrangement being found throughout the mammalian series. It must be said, however, that in three chimpanzees from which the brains were removed, a few hours after death, by Professor H. C. Chapman and the writer, in spite of preconceived notions, this was found to be clearly not the case, and in the orang, the cerebellum was covered to a very slight extent only, postero-laterally. There are few of the lower monkeys, however, in which the man-like relation of these parts does not exist, and in one, at least, the squirrel monkey (Chrysothrix) of South America, this posterior projection is even greater than in man himself.

Observation renders it quite probable that mental capacity in these animals has, to a considerable degree, maintained a relation to the complexity of detail in brain structure, although undoubtedly, from a mere comparison of human and anthropoid brains, a far greater degree of intellectual power than that which really exists, might be expected from the latter; it should be remembered, however, in favor of the ape, that the specimens from which our ideas of their intelligence have been derived, have for the most part, been very young, and it is possible that more mature age may bring with it a higher degree of mental faculty. On the whole, however, it is quite certain that the intelligence of the lower animals has been greatly overestimated. All experienced observers of their actions know how easy it is to place a motive and an understanding where none probably exist. It is difficult, except after long training, to withstand the influence of the subjective tendencies of the mind, which lead the observer to translate into the

terms of his own intelligence, those actions which seemingly correspond to his own desires, and there are few works on this subject in which constant evidence is not given of its presence. In experimenting with the animals which form the subject of this paper, the difficulty was constantly met with, and a large proportion of the phenomena observed were set aside, reluctantly in many cases, because of the doubt.

In the slow development of anatomical structure, the presence or absence of a single bone or muscle must be of vast importance in working out the pedigree of an organism, and enough has been said to show how varied are the directions in which man's alliances seem to point.

It is held generally, in popular misconceptions of the doctrine of evolution, that man is a direct descendant of the higher apes, and the gorilla is commonly looked on as being his nearest progenitor. From the standpoint of science, however, no student of biology will maintain that the ancestry of man has yet been fully traced, but will limit himself to the conviction that at some period of the prehistoric world, the forces of nature, acting from without, on the plastic materials of life, have brought down from an unknown point of departure—perhaps among the lemurs—two diverging lines of development, one of which finds its present type in man, the other in the Catarrhine monkeys and their highest form —the anthropoids.

Perhaps the future of science may unfold the details of development, but to do this it is probable that ages of geological upheaval will be required to bring above the ocean continents long buried, in which the process took place and in which the records are contained.

Manlike as are the apes, there is a contrast which the resemblance serves, in great part, but to intensify—anatomy finds similarity throughout and takes note of little that is unlike, while function, based upon these structures, has become so specialized and elevated during progress from the lower to the higher, as to become almost difference, and man and ape are in fact, as in time, separated by a gulf so vast that the furthest reach of science can catch, as yet, but shadowy outlines of the other side.—*American Naturalist.*

THE CLIFF-DWELLERS OF THE NEW MEXICAN CAÑONS.

The archæological and ethnological explorations in the southwestern territory, of which the *Tribune* published an account at the close of last season's work, have been continued with success under the direction of Prof. Powell during the season which has just ended. The wisdom of Congress in making provision for this work three or four years ago is becoming strikingly apparent as the railroads extend their lines into this, the most interesting region to the archæologist within the borders of the republic. Private collectors and specimen hunters are now overrunning the places which are thus made accessible, and all that remains of scientific interest which is movable becomes their spoil. The already abundant

collection of specimens in possession of the National Museum will become priceless as the opportunity for their duplication passes away.

The incompleteness of the work of exploring may be inferred from the fact that many of the ancient cliff villages seen by exploring parties during the last three months were merely sketched from a distance. They appeared to be in a remarkable state of preservation, but were not even visited. These villages, so far as could be learned from Indian guides, were never before looked upon by the eye of civilized man. They were inaccessible by any means at the command of the explorers, who, of course, will not rest satisfied until in some future trip they have reached them and carried away their treasures. The collections made from New Mexico and Arizona already number somewhere between 25,000 and 35,000 specimens of pottery, stone implements, weapons of war, articles of husbandry, musical instruments and a thousand and one things which appertain to and illustrate the daily life of the people who made and used them. Two parties, especially charged with the branch of science work referred to, were sent into New Mexico and Arizona last summer. One, in charge of Victor Mindeliff, went to the Moqui country, in northwestern Arizona, to make surveys of the Indian villages and ruins to be found in the region known as the province of Tusavon. The other party, under the direction of James Stevenson, has recently returned. It took for its field of exploration the cliff villages and ruins in the Cañon de Chelly and its branches. The main cañon has very rarely been visited by white men, and its branches—some of which are equal to it in extent, in grandeur of scenery and scientific interest—have, it is believed, never before been explored.

The "nests" (no other word is so expressive for the purpose) of the old dwellers herein were built, like those of wasps, in crevices of the cliff. The places selected were too small from front to rear to be properly termed caves. They were probably formed by the swirling eddies of the torrent, ages ago, before it found its way down to its present bed, hundreds of feet below. The solid upper crust is long and forms a lofty, sloping roof over a whole village. What could have been the character and habits of life of generations born and brought up amid such surroundings, with a sky of dull red rock overhead, with the outer world possibly narrowed to the limits between the two walls of the cañon, and even that outer world inaccessible except by a perilous feat of climbing such as none but expert gymnasts of this day would care to attempt; a little world upon which the Sun could only shine two or three hours of its daily round. It is to answer these question as well as may be that the explorers were sent out.

Colonel Stevenson was led to the selection of the Cañon del Muerte, in preference to others which branched off from the main cañon, upon either side, by the representations of his chief Indian guide, who said that ruins of a more interesting character than elsewhere were to be found there. The party entered the mouth of the cañon and went a day's journey along its bottom until they reached a place beyond which their wagons could not go, and here they established their camp. The walls of the cañon were of nearly uniform height, about 1,000 or 1,200 feet from top to base, always perpendicular, except where great

piles of debris, broken from the cliffs, had filled up a portion of the space below; now approaching each other, narrowing the cañon to a mere crevice in the earth less than 100 feet in width, and again spreading out half a mile apart.

Proceeding on foot three miles beyond the camp, the explorers found the ruins of a cliff village, so well preserved and remarkable that it more than fulfilled the promises of the guide. The place must have been the home of between 2,000 and 3,000 human beings. It occupied two "caves" under the same roof, but partially separated by a projection of rock. The extremes of the habitable floor were 1,500 feet apart, while the width from the rear wall of the cave to the edge of the precipice below might have been one-twelfth that distance. The floor of the two wider portions of the cave was studded thick with dwellings built of square stones laid in mortar, all of which were in a state of ruin. An edifice of grander proportions, and almost as well preserved as in the day of its occupation, nearly filled up the narrow space in front of the dividing rock projection to the edge of the precipice.

The fortress-like structure referred to consisted of a long, narrow building one story in height, divided into many rooms or dwellings, opening into each other, but having no communication with the outside except through the towers which stood at either end. The largest of these towers—that at the southern end—was three stories in height, with the joists for each of the upper floors projecting two or three feet beyond the outer walls. Holes through the floors formed the means of communication between the different stories, while window-like openings from the second story of the towers, looking out upon the roof of the connecting one-story structure, formed the only mode of exit from the fortress, if such it was. An inhabitant of one of the central apartments of this building, wishing to emerge to daylight and pure atmosphere, must have been compelled to pass through the bed-rooms and kitchens of all his fellow-tenants upon one side into the tower; then to climb up through the ceiling to the second story of the tower, swing himself by a wooden bar which still remains in place, out of one of the windows upon the roof of his dwelling, and thence pass by a ladder down to the floor of the cave—the "street" of the village. If his duty or pleasure led him to a greater distance, he still had the perilous journey before him down the rocky ladder, 300 feet to the bottom of the cañon.

Many interesting architectural designs were noted by the explorers, which can not be described here. No evidence of the use or knowledge of metals was found; stone implements fashioned all the materials out of which the structure was built, of which fact the rough but careful chiseling of the stone gave abundant evidence. Cross-pieces were laid upon the joists for the flooring of the towers, and upon these pieces twigs about the diameter of a man's finger were arranged side by side, but in series which formed a curious mosaic of angles and squares. In the larger division of the cave, and in the smaller division, one of the curious circular structures which might have been the places of worship, or perhaps of amusement, of the cave-dwellers, was found.

The structures are common enough in that section of the country, but these

were different in many respects from any before examined by the members of the party, and especially different in their interior ornamentation, which was quite elaborate. In one of them a wide band, laid on in bright, durable colors, ran entirely around the structure, resembling a Greek fret, with narrower bands above and below and with the interior spaces filled with curious artistic designs, the meaning of which none of the party could guess. Evidence of the long use of these places for some purpose was found in the fact that some seventy or eighty different thin layers of mud had been plastered upon the interior, each having in its time borne its own ornamentation in colors. The roofs of the buildings were gone, and the floors were covered with debris.

It was at this village that the discovery of skeletons was made. J. Stanley Brown, who accompanied Col. Stevenson, was one morning climbing over a portion of the ruins which had not before been visited, and observed some small round poles projecting from the face of the bluff, to which fact he called attention. By scraping away the debris, human skulls were reached, and further efforts disclosed entire skeletons. A regular burial-place of the ancients had here been broken into; two complete skeletons, with parts of two others, were found. Great care had evidently been taken to place the bodies away in the manner best calculated to insure their preservation. The place of their interment was in shape like a large oval baking oven, and the desiccated remains, in sitting posture, with knees and chin touching, had been placed within. The contents of the tomb were carefully exhumed and are now on their road to the museum. Hair of a brownish hue, which may, however, have been black at the time of burial, is still found clinging to the skulls; while the shriveled flesh and skin, as hard as stone, remains upon some of the lower limbs.

Another village in this cañon of equal extent and similarly situated, though in a more advanced stage of ruin, was visited, and some exceedingly interesting discoveries were made. Among the *debris* of the fallen building sandals, finely woven, but resembling nothing with which the present occupants of this Territory are familiar, were found, as also were portions of matting and of garments made from the fiber of the yucca. Evidences of the great antiquity of some of these ruins are mixed with those of later occupancy in a manner most confusing to the archæologist. The Indian guide, George, in reply to an inquiry upon the subject, said that the Navajo tradition went back twelve times the length of the life of their oldest chief, now eighty years of age, and that the ruins existed unoccupied then. This carries one back about 1,000 years, but the evidence is hardly reliable.—*N. Y. Tribune.*

THE MOA AT HOME.

EDWIN E. HOWELL.

Every one who has written anything about New Zealand for the past thirty or forty years, whether about its inhabitants, its archæology, its natural history or its geology, has had much to tell us about the great wingless birds that once inhabited that group of islands. From this great mass of material we have endeavored to sift out the leading and most important facts and present them to the readers of the *Bulletin* in a brief summary.

The Rev. Richard Taylor, F. G. S., thinks he was the first discoverer of the Moa (the name given to all these great fossil birds). While journeying to Poverty Bay, in the early part of 1839, he found the bone of a Moa near the East Cape, which the natives told him was the bone of a large bird which they called Tarepo, and which lived on the top of Hikurangi, the highest mountain on the east coast. He found later that the natives of the west coast called the bones Moa, and were entirely ignorant of the name Tarepo.

It seems probable, however, that to the Rev. W. Colenso, F. G. S., belongs the honor of first discovery of the Moa, as he was the first, also, to investigate the nature of the fossil remains and determine the struthious affinities of the birds to which the bones belonged. In 1842 he wrote: "During the summer of 1838 I accompanied the Rev. W. Williams on a visit to the tribes inhabiting the East Cape district. While at Waiapu I heard from the natives of a certain monstrous animal, while some said it was a bird, and others a person. All agreed that it was called a Moa; that in general appearance it somewhat resembled an immense domestic cock, with the difference, however, of its having a 'face like a man's;' that it lived on air, and that it was attended or guarded by two immense Tuataras, who Argus-like, kept incessant watch while the Moa slept. Also, that if any one ventured to approach the dwelling of this wonderful creature he would be invariably trampled on and killed by it. A mountain named Wakapunaki, at least eighty miles distant, in a southerly direction, was spoken of as the residence of this creature; here, however, only one existed, which it was generally contended, was the sole survivor of the Moa race. Yet they could not assign any possible reason why it should have become all but extinct. While, however, the existence of the Moa was universally believed (in fact to dare to doubt of such a being amounted, in the native estimation, to a very high crime), no one person could be found who had ever seen it. Many of the natives, however, had from time to time seen very large bones, larger, from their account, than those of an ox; these bones they cut up into small pieces for the purpose of fastening to their fish hooks as a lure, instead of the Haliotis shell."

Other Europeans have been told this same myth, and other high mountains have been designated as the dwelling place of this strange creature. It is hardly

necessary to add, however, that subsequent explorations have failed to reveal the hiding place of "the last Moa," and that we owe our entire knowledge of the bird to the study of its fossil remains. These have been found in many places and under varying conditions.

According to Dr. Haast, "the oldest beds containing Moa bones, are proved to belong to the great glacier period, where they occur in morainic accumulations and silt beds, as well as in fluviatile deposits, formed by rivers having issued from the terminal face of gigantic glaciers during that period. Here they have been traced as low as 100 feet below the surface. In the loess deposits they are also of frequent occurrence, where their existence has been proved to a depth of more than fifty feet. Advancing to the quaternary period, Moa bones are found in turbary deposits or in silt or loess on the plains or lower hills, in caves and in fissures of rocks, in fact, everywhere where favorable conditions for their preservation prevailed.

"From the observations we were thus able to make the conclusion has been forced upon us that these gigantic birds must have been able to sustain life over a long period, because the same species which occur in the lower lacustrine and fluviatile deposits are again found in the bogs and swamps, in the fissures of rocks, and in the kitchen middens of the Moa-hunting race, which latter evidently marks the end of the Dinornis age."

Dr. Hector mentions heaps of bones with stone implements, on the top of Corrio Mountains (South Island), 5,000 feet above the sea level.

Mr. B. S. Booth, (Transactions of New Zealand Institute, 1874), gives a very interesting description of a Moa swamp at Hamilton.

Mr. Booth says: "The surface lagoon, before being disturbed, was rather higher than the surrounding surface, and consisted of from one to two feet of black peat mixed with a blackish silt which rested on and was mixed with the bones to the very bottom" Below the bones there was one foot of a fine whitish, very soft, and somewhat elastic clay. "The bones were deposited principally in the northeast part of the lagoon, in a space exactly the shape of a half moon, forty feet from point to point, and eighteen feet across the center, and varying from two to four feet deep."

He estimates that nearly seven tons of bones were taken out of this space, most of which were badly decomposed, and that the number of individual birds could not have been less than 400. The bones "lay in every imaginable complication of tangle," with "no bone on top."

"A great quantity of quartz gravel and smooth pebbles occurred among the bones, and in the shallowest parts of the deposit, under pelves or breast bones which had not been disturbed, they lay in bunches. "There was no gravel in the lagoon except amongst the bones, and no small gutter or water course could be found by which it might have come in."

The only explanation, apparently, which can be given for the presence of the pebbles is that they were brought there in the gizzards of the birds This theory is supported by numerous instances where similar pebbles have been found con-

nected with Moa bones in such a way as to admit of no other explanation than that they were connected with the birds. The bones on the top were in a much better state of preservation than those at the bottom. There were a large number of bones that had been broken and healed. "A disease of the foot appeared to have been very prevalent amongst them, as a great number of the joints presented unmistakable indications of rot, so much so that some of the toe joints had even grown together."

There were no bones of young birds near the top, and no fragments of eggs were found anywhere in the deposit, although careful search was made for them.

After stating these and other facts, Mr. Booth goes on to discuss the different theories to account for this wonderful accumulation of bones. He shows that they could not have been deposited by running water, neither could the Moas have been surrounded and driven in there in such great numbers by sweeping fires, the birds could not have been bogged, certainly not the latter ones, with two or three feet of solid bones under them. And that the bones were not thrown there by savages seems proven by the fact that not a trace of their work could be found, not a hacked or scratched bone nor an implement or trinket of any kind.

Mr. Booth thinks that a true explanation of the deposit explains the extinction of the Moa, at least in that section, and that that time was much earlier than the date generally accepted, and was caused by the gradual lowering of the temperature until the warmth of the earth and air was not sufficient to hatch the eggs of these birds, from which time they gradually declined, until they finally all disappeared. "When the frost and snow of winter began to set in, though far milder than now, it would have distressed the Moa, as on account of its great size it could not find shelter like smaller birds, hence it would select places where it found the most warmth.

The spring water in the bone pit being of the same temperature as the earth, and far above freezing point (in fact, it may have been a thermal spring), when all around the bird could not put down his foot without being bitten with frost, or without placing it in snow and ice, what would be more natural for them than to step into this comparatively warm water, which, to some extent, would relieve their suffering from cold in their lower extremities. Thus, the period when frost and snow began to set in I place as the commencement of the deposit of bones in this pit. The accumulation would have been very gradual, perhaps for centuries, and the periodical deposits would only have increased at the same rate as the frost and snow. This process continuing, until not even in the most favored places would their eggs hatch, and the last of their race were, therefore doomed to annihilation, a period would arrive which must have been with the poor birds a time of indescribable suffering. Thus afflicted with pain, famishing with hunger (as whatever their food was it lay deep under the snow-mantle of the earth), and finding cruel nature arrayed against them, pinching their bodies with piercing winds, from which they had no shelter, and cutting their feet with ice and frost, were it only as an alleviation of pain when dying, I can see nothing more

natural than for them to have plunged into this spring. The water being of the same temperature as the earth, would feel quite warm to them, and there being no inducement for them to get out, as their food was cut off, they would settle in deeper and deeper, and remain till numbness and hunger put an end to their suffering.

Hence I account for the bones being soundest on the top, as they would have been deposited so much later. Hence, also, I account for there being no bones of young birds on top, as it was long after incubation ceased that the old family was gathered to its resting place. Hence I account for the absence of egg-shells, as these deposits only took place in the winter season, which was never the breeding season with the birds. And by the trampling round of the birds when in the spring, I account for the equal distribution generally of the gravel amongst the bones; the trampling being the disturbing cause from which alone some bunches of gravel from the gizzards escaped by being covered with a breast bone or pelvis.

Mr. Booth further adds: "If it is asked, why are there no bones in the surrounding lagoons? my answer is, that as they are all (as far as I have examined)surface lagoons, they would have been frozen over when the cold drove the birds into the spring water which never froze."

This theory of Mr. Booth has much to recommend it, and we agree with him that the theory of cold seems more plausible to account for the heaps of bones at Lake Wakatipu, described by Dr. Hector, than the theory of fire which the Doctor advances. The Moas would certainly have been quite as likely to have sought shelter under a precipitous ledge of rocks to protect them from cold snow storms as from sweeping fires, and would have been much more likely to have reached such shelter. Notwithstanding, they perished in clusters. This occurring periodically, perhaps for many years, would naturally account for the many distinct skeleton heaps found by the Doctor in that place.

Many many pages have been written in relation to the time the Moa became extinct. That it was contemporary with man, and owes its final extinction to him, is a fact accepted by all, but whether the old Moa hunters were the ancestors of the present New Zealanders or, if not, whether the ancestors of the Maories hunted the Moa at all, or inhabited the islands before the Moas were all gone, is still a disputed question, with competent observers on each side.

As bearing on the time when the Moa became extinct in that part of the South Island, we quote again from Mr. Booth's paper, "I find below a certain level that would leave the whole Maniototo plains under water, there are no Moa bones to be found, with the exception of about the mouths of the burns coming in from the hills, where the bones have been brought down by freshets." * * * "Now what does this fact point to? The only answer I can give is that the Moa was extinct in this locality when the whole Maniototo plains, from the level spoken of, were yet under water." These statements by Mr. Booth agree well with the position maintained so stoutly by Dr. Haast, previously quoted, who is the strongest and most prominent defender of the theory of the early

extinction of the Moa throughout the whole of New Zealand. He claims that it became extinct before the occupation of the islands by the present Maori race, and gives us a great deal of geological data in support of this position. At Moa-bone Point cave he found a stratum "three or four inches in thickness, mostly consisting of refuse matter from human occupation, and of ashes. It was especially in some localities, as for instance near the entrance of the cave, replete with kitchen middens of the Moa-hunters," among which were found polished and unpolished stone implements, a few small tools made of bone, personal ornaments, fire sticks, etc. "And now as it were at once, the Moa-hunters disappeared from the scene," and the cave remained uninhabited for a considerable space of time, as shown by "the clear line of demarcation between that layer and the shell bed above it, in which no Moa bones were found," and by the deposit of blown sand between the two, about a foot thick at the entrance of the cave, and gradually thinning out as it advanced toward the interior. Below this line, Moa bones and fragments of egg-shells were very abundant, and with them were the bones of seals and a few other animals. Above this line, which doubtless represents a long interval of time, there were no remains of the Moa to be found, and the deposits showed the cave to have been occupied for a long period by a race who lived mostly upon shell-fish, a food which was apparently used very little by the Moa hunters. Dr. Haast and others give us the details with reference to a number of other localities which tell the same story, viz: That the Moa and Moa-hunters flourished and passed away, and that another race, with different habits, *after a long interval*, occupied the same places; still after all it may have been the same Moa-hunting race returned, after long wanderings, to their former habitat. There being no more Moas to eat, they feasted on shell-fish.

The Reverends W. Colenso and J. W. Stack, gentlemen versed in Maori lore, have reached nearly the same conclusions as Dr. Haast, from entirely different data. According to these gentlemen, the old traditions, songs, and poetry of the New Zealanders furnish no evidence that they knew aught of the Dinornis. The word Moa occurs but seldom in their songs and legends, and has various other meanings besides that of a large bird, and it was sometimes used figuratively in allusion to the myth that the Moa lived on air. A love-sick maiden who mourned her lover and would not eat was christened Hinemoa (the young lady who lived on air).

Mr. Colenso has evidently given this whole subject a great deal of time and careful study. In his paper, written in 1842, previously referred to, he says: "From native tradition we gain nothing to aid us in our inquiries after the probable age in which this animal lived; for although the New Zealander abounds in traditionary lore, both natural and supernatural, he appears to be totally ignorant of anything concerning the Moa, save the fabulous stories already referred to," and thinks it certain that this would not be the case if such an animal lived within the times of the present race, but in an exhaustive paper published in the Trans-

actions of the New Zealand Institute, three years ago, he sums up his final conclusions thus:

1. "That the bird *Moa* (some of those of its genera and species) was really known to the ancient Maori.

2. "That such happened very long ago, in almost prehistorical times: long *before* the beginning of their genealogical descents of tribes, which, as we know extended back for more than twenty-five generations.

3. "That this conclusion is the only logical deduction from all that I have been able to gather; whether myth, legend, proverb, song, or the etymological rendering of proper names of places, persons, etc."

In regard to the numerous accounts published of Maori descriptions of the Moa, he says: "From January, 1838, (when I first heard of the *Moa*), down to 1842, and later, no man could possibly do more than I did in my quest after it, and no man could have had better opportunities." * * * "And I again assert, that it was through me that the Maoris generally got to know of the *Moa* having been a *real* (or common) *bird*. I showed them repeatedly, at the station, the plates in Rees' cyclopædia, containing all the *Struthious* birds, and told them of their habits, etc., and of the opinion of the extinct *Moa;* that information was carried almost everywhere (with, no doubt, many additions), and that information, together with simple leading questions on the part of the inquirers (especially when put by the governor of the colony, or any superior,—which, according to Maori etiquette, would not be negatived even if wrong) and, also, with but a small knowledge of the Maori tongue on the part of the Europeans, fully explains all *to me*, and that very satisfactorily."

Mr. Colenso remarks that the condition of things forty years ago, or before the colony was established, was very different from what it is now, and says his inquiries "were carried everywhere throughout the length and breadth of the North Island; they were the constant theme of conversation among the Maoris, who then had little of a novel nature to talk over,—increased, from the fact of rewards being offered for bones, feathers (if any) and for information."

It requires but little knowledge of the workings of the savage mind to see the force of these arguments.

Notwithstanding, many competent observers believe that the Moa became extinct in very recent times, Dr. Hector, Director of the New Zealand Geological Survey, among the number. Mr. Walter Mantell (son of the eminent geologist) was the first explorer of the artificial Moa beds, soon after the settlement of the colony, and advanced the idea that Moas existed to very recent times. And Mr. Mantell seems very certain that Maoris in the south at the date of his early explorations, in 1846, were well acquainted with the former existence of the Moas and the circumstances which led to their extinction. He also thinks that cannibalism prevailed, but in the North Island only, at the time the Moa was used for food.

Several bones of the Moa, with the dried ligaments still attached, have been

found, together with portions of the skin and a few feathers; although Dr. Haast claims that the conditions were exceptionally favorable for their long preservation, others contend that they cannot be very many years old.

Capt. Hatton thought that the weight of evidence goes to show that the remains from the Earnsclugh cave "are not very old, and that probably they do not date further back than the commencement of the present century," but in speaking of the bones with dried skin from the Knobby Ranges, found more recently (1874) in a crevice among the rocks, he says: "The extraordinary juxtaposition of decayed and lichen-covered bones with well preserved skin and flesh seems to me to point to some peculiarity in the atmosphere which enabled flesh to resist decay when shaded from the rays of the Sun, and by no means to prove that the bird to which this neck and flesh belonged lived at a later date than those whose bones we now find buried under the soil."

D. W. Murrison thinks that if what Dr. Haast and Mr. Colenso say is true for the North Island, it certainly cannot be made to apply to the South Island, and says, "I think from the evidence we are in possession of, there is every reason to suppose that the Dinornis has existed within the last hundred years." And thus the discussion is kept up as to the time when the Moa became extinct.

As a sample of the traditions which Mr. Colenso explains away, we quote from Mr. J. W. Hamilton (Trans. N. Z. Inst., 1874): "In 1844, at Wellington, I was present, as Governor Fitzroy's private secretary, at a conversation held with a very old Maori, who asserted that he had seen Capt. Cook. This Maori, so far as my memory now serves me, I should guess was seventy years old, at all events he was brought forward as the oldest of his people then residing about Port Nicholson. Being asked had he ever seen a Moa, he replied, 'Yes, he had seen the last one that had been heard of,' and on being questioned described it as a very large bird with a neck like that of a horse." Mr. H. further says: "In 1844, and for many years later, it was believed by our people for a certainty that the Moa was still to be found alive in the South Island, of which very little was then known," and that stories were currently reported of one or two old settlers in the south about Otago and Foveaux Straits who had actually eaten Moa flesh.

For the details of the osteology of these birds we must refer our readers to Prof. Richard Owen's description published in the Transactions of the Zoölogical Society of London, begun in November, 1839. Prof. Owen at first made two genera, *Dinornis* and *Palapteryx*, but afterward discarded the latter genus and referred all the different species to the genus *Dinornis*.

In 1875, Dr. Haast, Director of the Canterbury Museum, proposed two families, with two genera in each family, thus: Family *Dinornithidæ:* (a) genus *Dinornis;* (b) genus *Meionornis*, and family *Palapterygidæ:* (a) genus *Palapteryx;* (b) genus *Euryapteryx*.

Under these four genera, as proposed by Dr. Haast, there have been about twenty species described. These species are founded mainly on the size and proportion of the bones—particularly the bones of the leg, and it is not improba-

ble that as more careful comparisons are made of larger series of bones, the number of species will be reduced. It is an interesting fact that Cook's Straits, which separates the two islands, "seems to have been an effectual bar to any migration from one island to the other," as the same species are not found on both islands. Prof. Owen infers from the beak of the *Dinornis*, "formed after the model of the adze or pick-axe," and "the robust proportions of the cervical vertebræ, especially of their spinous processes," that it had "a more laborious task than the mere plucking of seeds, fruit, or herbage," and that "the beak was associated with the feet in the labor of dislodging the farinaceous roots of the ferns that grow in characteristic abundance in New Zealand."

Portions of dried skin and a few feathers of the *Moa*, as already stated, have been found; the color of the barbs of the feathers are chestnut red and the rounded portion of the tip is white. These feathers, according to Capt. Hatton, show the bird to have been more nearly allied to the American Rhea and Emu than to any of the struthious birds of the old world.

Fragments of *Moa* eggs are quite numerous, particularly in the kitchen middens of the Moa-hunters, and a few nearly or quite perfect specimens have been found. Dr. Hector describes one 8.9x6.1 inches in diameter, which contained the remains of an embryonic chick. Another specimen measured 9.5 inches long.

These are certainly monstrous eggs, and yet the fossil bird of Madagascar (*Aepiornis*), although a smaller bird than the great *Dinornis*, laid a much larger egg, two specimens of which are in the Garden of Plants, Paris, and measure respectively 13x9 and 12x10 inches in diameter. And yet, after all, neither of these birds laid as large an egg in comparison to its size as does the *Apteryx* of New Zealand at the present day.

And now as a fitting close to this brief summary, we quote from Prof. Owen's first paper on the *Dinornis:* "The extraordinary number of wingless birds, and the vast stature of some of the species peculiar to New Zealand and which have finally become extinct in that small tract of dry land, suggest it to be the remnant of a larger tract or continent over which the singular struthious Fauna family ranged. One might almost be disposed to regard New Zealand as one end of a mighty wave of the unstable and ever shifting crust of the earth, of which the opposite end, after having been long submerged, has again risen with its accumulated deposits in North America showing us in the Connecticut sandstones of the Permian (Trias) period the foot-prints of the gigantic birds which trod its surface before it sank; and to surmise that the intermediate body of the land-wave, along which the *Dinornis* may have traveled to New Zealand, has progressively subsided, and now lies beneath the Pacific Ocean."—*Natural Science Bulletin.*

BOTANY.

SEEDS: THEIR PRESERVATION AND GERMINATION.

REV. L. J. TEMPLIN.

In all the realm of nature there are few if any other objects that conceal so many wonders or around which cluster so many interests as that of a perfect, living seed. Though apparently possessing no more life than a grain of sand or a small gravel, yet hidden within that lifeless exterior, and folded away in those simple cerements, is a living germ, possessed of latent powers and energies, that, when subjected to favorable conditions, and animated by the vital principle, will develop a living, growing vegetable organism. Every seed is the product of a plant and is the result of the fertilizing influence of the pollen on the ovules of a flower. The parent plant has not only given life to each seed, but it has so stamped on it the parent's nature and characteristics that the resulting plant must resemble its parent in all essential particulars.

It is true that each plant may vary slightly from its parents, in those qualities that are not essential to specific existence, but these variations are always within narrow limits with a general tendency to revert back to the parental form.

I am aware that many able scholars and noted naturalists hold the opinion that these variations may go on in a particular line until it results in the production of a new species; but that any species has ever been produced by such variation the proof is not forthcoming, although it has been "sought for carefully and (almost) with tears" by hundreds of the most careful observers and expert investigators of the age. A seed is strictly the product of nature. It is inimitable by art. With all his knowledge of the elements and his mastery over the forces of nature, man cannot construct a seed. Men who seem ready to accept the theory that living organisms may arise, spontaneously, from lifeless matter, cannot, with all the materials of nature in their possession and all her forces at their command, in a single case produce life from non-living matter. They may manipulate, organize, and combine to the utmost of their skill, yet in the absence of the living principle, which comes alone from a vital connection with a previously living organism, no life will or can appear. Nothing short of a Divine Giver of life could have originated the seed. The office of the seed seems to be two-fold; first to facilitate the dispersion of plants by the ease with which they may be conveyed from one place to another; second, to perpetuate the species by the number of their production and the facilities their forms offer for preservation from one season to another.

Seeds vary almost infinitely in their form and construction as well as in the constituent elements of which they are composed. A careful examination, however, will show that every seed contains a living germ or embryo, which is really a plant in miniature, in or around which is stored up a supply of food for the nutriment of the young plant till it shall have attained age and strength to secure this from the soil and air. The materials thus stored up consist of starch, gluten, albumen, oils, gums, and various other substances. The kernel of most seeds is composed largely of starch and the albuminous compounds. It differs, however, in different plants, being oleaginous in the poppy, castor bean and peanut; mucilaginous in the flax, fleshy in the pæony and barberry, corneous or horny in the coffee, and having the appearance and consistence of ivory in the ivory-palm. The seeds of the cereal grains and of grasses are chiefly composed of starch. The wisdom and goodness of the Creator are strikingly shown in the selection of this material to compose the principal part of the seeds of that class of plants upon which not only the well being but the very existence of man and the higher animals depend. Starch is not only a very important article of food but it is a substance not readily affected by cold or moisture, hence seeds composed of this material will endure great exposure without injury to their vitality. *Germination*, or the awakening of the plant germ to active life is affected, and, to a considerable extent, controlled by several external influences. The plant food stored up in the seed cannot be appropriated to the use of the germ until reduced to a liquid condition. Or in other words the plant cannot digest solid food. But it must not only be dissolved but it must be conveyed from those parts of the seed where it is stored to the germ before it can be used by that or for its benefit. For these purposes water is essential to the germinating seed. But there is a limit to the amount of water that is beneficial to the seed at this time.

Aquatic plants grow very well in the water, and many seeds of land plants will germinate when immersed in water, but they will not make a healthy growth in the presence of so much water as to exclude the air. For most seeds a moist but not wet soil is most conducive to a healthful germination and vigorous growth.

The presence of atmospheric air is also essential to the proper germination of seed. This will be better understood when we consider the changes that take place in the seed during the process of germination. A growing plant in the presence of air and sunlight absorbs, through its leaves, carbonic acid from the air; this is decomposed in the plant and the oxygen is expelled while the carbon is employed in building up the plant structure. This process can take place only in the presence of sunlight. The reverse of this takes place in the process of germination, which is generally most readily performed in the dark. During this process the seed absorbs oxygen which, combining with a portion of the carbon of the seed, forms carbonic acid or carbonic anhydride, as the chemists now call it, which is given off to the surrounding air, thus reducing the substance of the seed. The total loss in this process, according to Boussingault, was, in an experiment of his as follows:

	TOTAL WEIGHT.
Seeds	8.626
Plant	4.429
Difference	4.097

thus showing a loss of more than one-half of the solid substance of the seed during germination. The process by which this matter disappears from the seed is a real combustion and results in the elevation of the temperature of the seed to a greater or less degree.

The necessity of the presence of air to the germinating seed leads to the necessary conclusion that if seeds are buried so deeply in soil, or so surrounded by water as to exclude the air, germination cannot take place. The seeds may rot but they cannot grow.

This leads to a consideration of the question as to the depth at which seeds should be planted. This will be found to depend upon a variety of circumstances. It is evident that a small seed should not be planted as deeply as a large one. The depth should also vary with the climate and the soil. In a dry climate or a porous soil the seeds must be buried to a greater depth than if the reverse be true.

This is necessary that the requisite amount of moisture may be secured at the same time the aridity or porosity of the soil is more permeable to air, thus insuring a supply of oxygen to the germinating seed at a greater depth than if the soil were compact or saturated. In some very dry countries it is necessary to bury seeds at a much greater depth than would be safe under other conditions. Thus it is said that the Indians on some of the dry plains of Colorado plant their corn ten to twelve inches deep, by this means securing sufficient moisture to insure its germination and growth, which it would not have if planted at a much less depth. As a general rule, in ordinary agricultural soil seeds may be planted to a depth of about five times their diameter with fair promise of success, varying from this according to the condition of the soil as to compactness and moisture.

The limits of certain degrees of temperature are also essential to the healthy germination of seed. The seeds of some arctic and alpine plants are known to germinate at the temperature of melting ice, while some of a tropical habitat require a temperature equal to that of our hottest days to awaken their germs into active life. Between these extremes seeds are found germinating at every variation and degree of temperature. For all species of seeds there are certain limits above or below which they will not germinate. These limits vary, of course, with the different kinds of seeds.

The following table, given by Johnson, (*How Crops Grow*, p. 133,) shows the extreme temperatures between which some of our most common agricultural plants germinate, and also the degree at which the process takes place most rapidly:

	LOWEST.	HIGHEST.	MOST RAPID.
Wheat	41 ° F.	104° F.	84° F.
Barley	41	104	84
Pea	44.5	102	84
Maize	48	115	93
Scarlet Bean	49	111	73
Squash	54	115	93

Sachs, from extensive experiments with agricultural seeds, concludes that the lowest temperatures at which they will germinate range from 40° to 55°, and the highest from 102° to 116°.

Göppert found none to germinate below 39°. DeCandolle sprouted mustard (*Sinapis alba*) at less than 32°, and thinks it would have germinated at a still lower temperature had it been possible to keep water around the seed in a liquid form at a temperature of 31.1° or 30.2°.

Mustard germinated in seventeen days at the lowest degree at which water could be retained in liquid form. The seeds of this plant germinated at

35.6° in fifteen days.	39.2° in nine days.
54° to 68° in two days.	69.8° in one day.

At 77° in a little over one day; at 82.4° only a small portion of the seeds came up after three days; at 104° none.

It is said the cocoanut will not germinate readily under about 120° Germination is influenced not only by the degree of heat but also by the uniformity of the temperature.

In the investigation of the relation of heat to the phenomena of plant-growth Köppen has reached the conclusion that a uniform temperature is more favorable to plant-growth than a variable one even though the variable one be a higher one. He concludes that any variation in the temperature is prejudicial to the growth of the germ, and that a low but uniform temperature will result in a more rapid germination than a higher one if subject to variation. A uniform spring temperature with a cloudy sky is, in the opinion of this authority, more conducive to rapid development of vegetation than an alternation of hot days and cool nights though the average temperature be the same. Sachs is of the opinion that the degree of temperature at which germination takes place has an important influence on the relative development of the different parts of the plant. A low temperature, according to this observer, is unfavorable to the development of new roots and leaves, but the organs already formed in the embryo are greatly extended; but under the influence of a high temperature new roots, leaves and buds are rapidly formed even in advance of the complete development of those already existing in the embryo.

Though not fully understood in all its bearings the question of temperature is recognized as exerting a capital influence on the phenomena of germination. A very important influence also is exerted on germination by the presence of light.

In former times it was believed that this would not take place in the presence of direct sunlight. But this view is now generally rejected, as it is well known that seeds frequently germinate while lying on the surface of the ground and exposed to the full light of the Sun. But the probability is that even in this case the germination principally takes place in the night, and that this does not disprove the general theory that direct sunlight is detrimental to change. The change that takes place in the substance of the seed during this process seems to demand such an explanation. But while there is some doubt on this subject, there is none whatever that certain rays of light do have a very important influence.

About forty years ago Robert Hunt made extensive experiments to determine the influence of light on the germination and growth of plants. The conclusions to which he was led so far as germination was concerned are:

1. Light prevents the germination of seeds.
2. Actinic, or chemical rays quicken germination.

These views have been called in question by several able investigators. But this seems to have grown out of the fact that sufficient attention has not been given to the distinction between germination proper and plant-growth. But this distinction is of capital importance as these different processes involve exactly opposite principles and are attended and followed by entirely different phenomena.

In germination oxygen is imbibed and carbonic acid exhaled, while in plant-growth carbonic acid is absorbed and oxygen exhaled. The conclusion at which we arrive is that the chemical rays penetrating, as they do, the upper stratum of the soil, while the luminous and calorific rays are cut off, determine the germination of the seed. As corroborative of the correctness of this view, as well as of the wisdom of the adaptation of the laws of light to the demands of the vegetable world, it is pertinent to remark that during the spring, when germination generally takes place, the actinic rays predominate, and during the summer, when wood-growth is the chief desideratum, the luminous rays that exert the most potent influence in the development of this part of the plant, are in excess of the others, while during the latter part of the season there is a preponderance of the calorific rays which exert a capital influence in determining the physiological processes of flowering and fructification.

It is a well established fact that electricity exerts a very marked influence in accelerating the growth of plants. In 1782 Dr. Marat found electrified seeds germinated many days sooner than those not so treated but otherwise subjected to the same conditions. These conclusions have been verified by many experimenters from that time on. It has even been found that seed that from age would not grow at all under ordinary conditions, after being subjected to electricity for some hours grew vigorously. Considerable light was thrown on this subject by Pouillet, who in 1825, proved that in the process of germination a notable quantity of electricity is disengaged. It is claimed by some experimenters that an electrified wire buried beneath growing plants or even stretched in the air above them exerts a very strong influence in accelerating their growth. I

come now, in the last place, to consider the question: How long will seeds under any circumstances retain their germinative power? Long experience has shown that under ordinary conditions the various farm and garden seeds will retain their vitality from one to eight years. Regarding this there is no difference of opinion. But, from the assertion that, under extraordinary circumstances seeds have been known to retain their power of germination for scores of years and even centuries, there is strong dissent. Among the most noted opposers of this theory is Mr. Thomas Meehan, editor of the *Gardener's Monthly*, and one of the ablest vegetable physiologists of the age. He says, (*G. M.*, Vol. 17, pp. 212,) in speaking of the notion "that seeds usually with a limited vitality will live for an indefinite period when in the ground, or 'Egyptian tomb,'" that "There is no good evidence of this." Again, speaking of the reported growth of poppy seed that had lain dormant in a Grecian mine 2000 years old, he remarks, (*G. M.*, Vol. 18, p. 344): "We know of *no* evidence satisfactory to us, that any seeds have been found vital under the extraordinary circumstances claimed. The whole theory of great vitality through long periods when buried in the earth, is at best founded on nothing but shrewd guesses, and in the main on the evidence of persons of no more importance in a scientific point of view than those who believe that wheat is transformed into chess." But at another time (*G. M.*, Vol. 12, p. 173,) he admits that he had formerly held the opinion that Magnolia seeds would never germinate after they had become dry. But he found this opinion to be erroneous and gives facts to disprove it as follows: "Once we found a package which had been thrust under a rafter in a tool shed in spring, which grew as well as any. More recently, Mrs. Col. Wilder found a package of *Magnolia soulangeana* seed in Mr. Wilder's wardrobe, which had been there between two and three years, and which on sowing, produced a plant for every seed."

If everybody had been mistaken regarding the longevity of these seeds, may not those be in error who refuse to admit the extraordinary vitality claimed for some seeds under special circumstances. Let us inquire somewhat concerning this question. Mr. D. C. Eaton, of Boston, in a "Yale Agricultural Lecture" states that "Cucumber seeds have been kept seventeen years; corn, thirty; French beans, thirty-three, and from one bag of seeds the Jardin des Plantes was supplied with sensitive plants for sixty years.

The *Gardener's Monthly*, (Vol. 23, p. 24,) gives us the following example of vitality: "Mr. LeRoy, of Columbia College, looking over, in the winter of 1879–80, the plants of Wilkes' Exploring Expedition, collected in Patagonia, between 1838–42, found three seeds of a gourd, which were planted in his garden in the spring of 1880. Two of the three grew and bore fruit the same season. This fixes forty years of vital power for these seeds."

But if these seeds had been perfectly protected from air and moisture why might not this vitality have extended to centuries just as well as it did to decades? According to Johnson, (*How Crops Grow*, p. 305,) Girardin sprouted peas that were over a century old. It is said that Grimstone with great pains raised peas from a seed taken from a sealed vase found in the sarcophagus of an Egyptian mum-

my, presented to the British Museum by Sir G. Wilkinson, and estimated to be near 3,000 years old." And again, "Count Sternberg and others are said to have succeeded in germinating wheat taken from an Egyptian mummy, but only after having soaked it in oil."

After mentioning some failures to revive seeds that had lain long dormant, Mr. Johnson adds: "The fact appears to be that the circumstances under which the seed is kept greatly influences the duration of its vitality." The following item I find in my scrap-book, but the authority for the statements made is lost: "Seeds found with the coins of the Emperor Hadrian in an ancient barrow in England, and a heliotrope from a Roman tomb 1,500 years old and more, vegetated and grew vigorously. The same was the case with wheat, rose and clover seeds found with an Egyptian mummy, and Indian corn from a Peruvian mummy 1,200 years old." An anonymous writer gives an account of the draining of a bog on the estate of a gentleman in Scotland about the year 1820. The drain had to be cut through a ridge to the depth of forty feet. At the bottom of this and extending out under the bog was a stratum of sandy soil. In this were found buried acorns of the black oak species. These, on being brought up to the surface where they were subjected to the influence of light and warmth, germinated and grew.

Black oak logs had occasionally been found buried in the bogs in that region, but none had been known to exist on the estate in question for 300 years. Had these acorns been buried in some convulsion of nature, or during a change of land in that vicinity and lain for ages retaining their germinative power till accidentally thrown out to grow? Who can tell us? Or shall we take that easy method of avoiding all intellectual toil by discrediting the whole narrative.

The *Scientific American* is authority for the statement that, "In the course of late explorations in the ancient ruins of Egypt, General Anderson, an English traveler, found enclosed in a sarcophagus beside a mummy, a few dry peas, which he preserved carefully and, on his return to Great Britain, planted in the rich soil of the Island of Guernsey. The seed germinated, and soon two little plants appeared, from which at maturity sufficient peas were gathered to plant quite a large tract of ground in the following season."

I close by simply asking, are all these statements and authorities to be set aside only because they do not agree with our opinions? or shall we accept them as facts that can be overthrown only by positive disproof?

PROFESSOR MEEHAN ON EVOLUTION.

Professor Thomas Meehan, in response to the invitation extended him at the Cincinnati Meeting to address the Biological Section on this occasion spoke on "Variations of Nature, and Their Bearing on the Doctrine of Evolution and the Theory of Natural Selection." He premised that the Doctrine of Natural Selection as propounded by Mr. Darwin could not be controverted in so far as the

continual dropping out of the intermediate forms was concerned, which left the extremes without connections and gave us the idea of distinct species. He thought there were some weaknesses in Mr. Darwin's method of advocating his views, but these removed only left Mr. Darwin's position stronger than he himself perceived. He then proceeded to show that variations in nature were much greater than Mr. Darwin evidently had knowledge of. The popular idea that no two leaves on a tree were exactly alike in every respect was shown to be literally true. Many illustrations were given and specimens exhibited showing the great variations in seedlings of the same species, often from the same seed vessel; some from the latter would be regarded by any botanist who found them wild, as distinct species. A series of sixteen cones of *Pinus rigida* was exhibited, each from a separate tree, all growing within a circle of twenty miles, and the central links being taken away left nominal *Pinus serotina* at one end, and *Pinus rigida* at the other. Other species could be made by taking the interior series of forms. The speaker contended that variation was not a mere condition, but had to be accepted as a primary law of existence. As no two things have ever been produced exactly alike, so far as we know, the result must necessarily be a wide divergence in time, and, as we know that death is also a certainty to individuals, distinct forms must certainly ensue.

Heredity, as established by Mr. Darwin, was next reviewed, and shown to be established as a counterpoise to variation. It held variation in check, but was finally overpowered by this, the greater force. Sex was an attribute of heredity. Sex in flowers had no bearing on the future good of the race, and therefore crossing by insect agency or otherwise had no reference to the good of the race by aiding variation in the direction of change to suit environments. It rather brought back what Mr. Darwin would imagine a useful variation toward its starting point. A variation which had started from the centre of a circle, had to be cross-fertilized if at all from the centre from which it sprung, and the progeny was thus brought back toward its parents starting point.

The next point made was that variations had no relation to the good of the individual or race. Numerous cases were adduced to show that the forms which had prevailed had not the slightest physiological advantage over the forms displaced, and that those who argued to the contrary were reduced to the solitary argument that there must have been some advantage, or the species could not have survived. It must be so because it is, is an argument which has no place in researches such as we are engaged in now. The actions and behavior of both plants and animals were not for their own individual good. Their whole efforts were in the interest of their progeny—for posterity—for the future—for objects wholly unknown to the individual. Yet we found from the science of the past that all this self-sacrifice—pleasant as it was made to be to the individual,—and ignorant as these individuals were of what they were working for, all had resulted in present harmony. In the speaker's language "we and all organic things are the invited guests of nature. She makes our stay with her as pleasant as possible: but she ruthlessly dismisses us the moment we cease to serve her future purposes."

The laws by which destruction was brought about, were then considered, and the manner in which species were created by the aid of this destructive power discussed; and how, under the operation of the law of heredity, surviving forms found a temporary standing ground, until the greater law of variation again finally removed them.

Finally the speaker took up the objection that Mr. Darwin's views were destructive of Christianity and showed that they were in reality the strongest confirmation of Christianity's essential features. To his mind Christianity differed from all other systems of religion by insisting on the necessity of self-sacrifice. We have "to do the Father's will" regardless of all consequences to ourselves, as the condition of happiness, and the Great Teacher himself sealed these doctrines which shine from almost every page of the New Testament, by the Saviour offering up His own life. This is precisely what science, as he had endeavored to trace it, was now teaching. A wiser power than any science had as yet been able to fathom, was directing all things to some far away object, to us unknown; not for the individual benefit of anything, except in so far as it was in harmony with this power, holding all things together for good in spite of the seeming clashings of individual interest, and he was assured that the time would come when evolutionists and especially those who advocated the theory of natural selection, would come to be regarded as true Christianity's warmest friends.—*Naturalist's Monthly Bulletin.*

CORRESPONDENCE.

SCIENCE LETTER FROM PARIS.

PARIS, January 13, 1883.

The doctrine which attributes all the diseases that men and animals labor under, to the presence in their tissues of *infiniment petits* animals or vegetables, is not exactly known, though popularly ascribed to M. Pasteur. Indeed at one period M. Pasteur was hostile even to the doctrine. If the distinguished chemist has not had the honor of the conception of the original idea, he has in a remarkable manner, multiplied its applications, and rendered demonstrations evident to minds obstinately rebel. Pasteur has shown materially, what was demonstrated logically. This tiny animal or vegetable, called *microbe* by M. Sedillot, has enabled M. Pasteur to arrive at two practical conclusions. Firstly—that the microbes so far known to us, can be cultivated artificially in certain liquids. Secondly—by this artificial culture, the microbes can be attenuated in such a manner, that, introduced into the organism of large animals, they there determine either a malady very much less intense than that resulting from the natural con-

tagion, or a simple modification which gives place only to some phenomena hardly appreciable, but which nevertheless preserves the animals from the natural malady which so ofter kills them.

This species of preservation is called vaccination, on account of its analogy with the vaccination of Jenner. It has proved efficacious in the case of the disease *charbon*, which attacks cattle and horses—the former especially, and *sang de rate* in sheep. With man the disease is designated malignant pustule.

These observations will serve to introduce a still further discovery made by M. Pasteur, in the case of the "red malady," or *rouget*, and which in the province of the Rhine, carries off 20,000 pigs yearly, and those of the white, the most valuable breed, especially. M. Pasteur has found the microbe of the disease; the parasite has the form of a figure (8), and resembled the same found in hen cholera; it is smaller and more difficult of detection, but its physiological properties are different; thus it exercises no action on poultry, but kills rabbits and sheep. The microbe artificially produced, when employed to inoculate pigs, induces the same symptoms as if the scourge had been spontaneously produced. When vaccinated with a benign pus specially prepared, the pigs were able to resist the the disease in its mortal form. However, it has been considered prudent to wait till spring for the results of additional experiment.

In the history of science, the spectacle has never been previously witnessed of a single individual making so many discoveries in a period so relatively short as Pasteur. He now gives us the results of his investigation into that terrible problem—hydrophobia. It is the malady which presents the most obstacles for inquiry. The saliva was the sole matter where the presence of the rabic virus was to be detected. But this saliva, inoculated either by bite, or injection direct into the cellular tissue, did not infallibly communicate the malady. Then even if the latter did show itself, the period of incubation could not be exactly determined. There were also other drawbacks. All these, however, were set at rest by a new and sure plan of action. Pasteur found that the central nervous system was the principal seat of rabic virus, and that it could be gathered there in a state of perfect purity; again, that this virus, taken from the surface of the brain by trepanation, if inoculated, communicated the disease surely and rapidly.

The symptoms of hydrophobia are variable, though proceeding from the same virus, and these variations depend on the points of the nervous system—the spinal marrow, or the brain, etc., where the disease may be localized and developed. The saliva rabical contains microbes along with the virus, either of which can produce death. The saliva of a man or a child, can be virulent, is contagious, and can kill by inoculation, from an excessive development of pus. The virus of an individual affected with hydrophobia is everywhere characterized by the same virulence, whether that virus be taken from the brain or the marrow, and so long as decomposition has not set in. Pasteur has conserved a brain pending three weeks with all its rabical virulence intact. Inoculating the surface of the

brain or the blood with virus, produces hydrophobia in the course of six to ten days and invariably fatal.

Hydrophobia induced by the injection of the virus in the blood, produces not the same symptoms as the malady resulting from the direct bite of a mad dog, or inoculating the surface of the brain. In the first case, the spinal marrow is immediately attacked. When a dog is inoculated and does not succumb, that does not prevent the animal from, later, contracting the disease. Pasteur records the spontaneous cure of hydrophobia after the first rabic symptoms were developed, but never after the acute symptoms set in. Cases have occurred, of the complete disappearance of the first symptoms and the development after two months of the acute symptoms, terminating fatally. In 1881, Pasteur inoculated three dogs, two died rapidly of madness, the third displayed the symptoms of the first stage of the malady, but nothing since, and though inoculated twice in 1882, by the brain, the animal never contracted the disease. This is an important factor in the road of prevention against hydrophobia. In the laboratory, there are also three other dogs to which the madness cannot be communicated, no matter how they may be inoculated. The aim of all the experiments is to discover a method to preserve dogs against hydrophobia, and so render their bites harmless to man. Pasteur does not despair of attaining this end. The brain of a cow, dead from hydrophobia contracted from the bite of a dog, communicated, by inoculation, death to all the animals operated upon. M. Pasteur has experimented on no less than 200 dogs, rabbits, and sheep; they have so far only thrown a brilliant light on the road to the solution of a terrible disease which never forgives. Within two years that desired solution has made more progress than it has within centuries.

The following is a simple and ingenious plan for utilizing the electric, which now supersedes the ordinary, bells in houses, and to convert them into clocks, to chime or strike, following the parent time-piece. The latter can be of any model provided it strikes or chimes. Attach the end of the negative wire of the electric gong to the metallic works of the clock, then arrange the positive wire with the hammer, that is, a little above it: when the hammer rises to strike the bell, it will touch the wire, the "circuit" will be thus interrupted, the current will pass, and will travel along the wires to set the electric gongs to tint. The tinting will be repeated as many times as the hammer of the clock rises, and touches the wire in its proximity. Every room, corridor, or passage, of a house, can thus be simultaneously informed of the exact hour by the mother clock.

Relative to time, the 21st of December is the winter solstice, and the days are the shortest of the year. The Sun, as is well known, cuts the day in two equal parts, by arriving at noon at the meridian. But if an almanac be consulted it will be seen, that on the 1st of December, the Sun rises at 7h. 34m., and sets at 4h. 4m,; the 15th of December, it rises at 7h. 49m. and sets at 4h. 2m.; the 31st of December it rises at 7h. 56m. and sets at 4h. 11m. Thus the days diminish during the forenoons throughout the month, while they augment during

the afternoons. How does it arise then, that the forenoon is shorter than the afternoon, the morning unequal to the evening? This anomaly or equivocation, is due to the circumstance, that since 1816 the clocks mark not the time, but the mean time. They are regulated after a fictitious, not the real Sun. The latter never arrives at the meridian two days in succession at the same hour. The "official" Sun is more regular, hence, perhaps why it was invented; the calculation is made for each day, by how much it is in advance, or behind, the true Sun, and the difference at noon is called the equation of time; that permits to have the mean, when we have the real hour. This difference begets the inequality between the forenoons and the afternoons. Accordingly then, as the mean time is advanced, or behind, will the mornings or evenings, indicated by a watch, give the inexact risings and settings of the Sun. These errors, in either sense, will be produced during the year, save the 15th of April, the 14th of June, the 31st of August, and the 24th of December, when the mornings and evenings will be equal, because the true and real Sun then agree as to the hour of passing the meridian. On the other hand, the most important differences will occur on the 10th of February, 28m.; the 14th of May, 8m.; the 26th of July, 13m.; the 1st of November, 32m. The maximum difference can thus amount to half an hour.

France may be said by her initiative of the International Electric Exhibition, to have given the impulse to electric illumination; she at present stands still, waiting to ascertain the results of the several rival systems before the public. The Edison system has never exactly taken here, but it is impossible to close the eyes to its working in New York, where the light is laid on with the regularity of gas and water, and automatically controlled with marked simplicity. If Paris remain a little behind, that must not be construed as a want of faith in the future of the electric light, but to the immense resistance the gas company here can make. Further, the Jamin candle, in favor here, possesses incomparable merits, its lighting is automatic, it burns by its inferior end, and it yields a greater total of illumination than other systems, though the initial production of the electric current be common to all. F. C.

TAXATION OF COLORADO MINES.

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There is a good deal of dissatisfaction expressed in Colorado over the passage by the Legislature of the bill imposing a tax on the net output of ores in that State, and Governor Grant is strongly urged to veto it. The status of the case is this. A man may spend any amount of money, say $25,000 upon a mine before he takes out paying ore. Immediately upon doing this, before he gets a dollar remuneration for the $25,000 previously expended, the valuable ore is assessed, and as it becomes really for some time merely the interest upon the $25,000 as principal, the interest is of course reduced. That is, a man invests $25,000 which he may lose altogether, but upon which he anticipates to realize, let us say, 10 per

cent, but by the taxation bill this is decreased at least to 7 per cent, and it may be to still less. As mining operations are in their very nature a matter of faith, and of sight, the disastrous results to the mining industry of the State passing such a law will be readily conjectured. One such was passed in Nevada, and capital went to other fields of investment at once. The spirit of the Colorado press and people is strongly against the bill and may prevail on the Governor to veto it.

F. E. S.

ASTRONOMY.

METEORS AND COMETS.

The fifth of Prof. Charles A. Young's illustrated lectures was delivered in the Church of the Strangers last night. The subject was "Meteors and Comets," and the learned lecturer made his audience acquainted with a great deal of astronomical information in a very entertaining way. A great variety of views were displayed on the screen, and the explanations of them were couched in terms easily understood by all attentive listeners. Prof. Young held in his hand a small grayish stone with a black crust as he ascended the platform to begin his lecture. He said that it was a piece of a large stone, weighing forty pounds, which fell from the sky in February, 1857, at Parnallee, in Southern India. The falling of meteoric stones was usually accompanied by loud reports, which to the startled hearers seemed to last fifteen or twenty minutes. Prof. Young said it was not probable that any such reports ever lasted more than two minutes. There had been numerous instances of the falling of meteoric stones in this country, one of the most remarkable of which was the falling of about 1,000 pounds of stone at Weston, Conn., December 14, 1807. In the cabinet of Amherst College there is treasured a meteoric stone which weighs 450 pounds.

A person seeing a meteor fall at night at first sees a ball of fire about the size of the moon. As the meteor approaches the earth, the light grows larger and brighter, like the head-light of a locomotive. Generally, a train of light follows the ball of fire. The falling of meteors is accompanied by loud explosions, and it has been claimed that these explosions occur at intervals when only portions of the meteor fall, while the main body passes on. Meteors first appear in the sky at a distance of eighty or ninety miles from the earth, and they disappear from view when at a distance of seven miles from the earth. They move through space at the rate of ten miles a second, and sometimes with a velocity of forty or fifty miles per second. There is not a single element in the composition of meteoric stones that is not found in the earth. The substance of the meteors, however, is put together differently, so that their mineralogy is unlike the mineralogy of the stones of the earth. Meteors are known to be heated when they reach the earth, but on one occasion, a meteoric stone, when dug out of the

earth, was found to be covered with ice. The majority of the meteors that strike the earth are stone, and not iron, as is commonly supposed. Some, however, are of pure iron. Out of the 500 or 600 meteoric stones that have been found on the earth and preserved not more than ten were iron.

Meteoric particles are striking the earth all of the time. Some astronomers estimate that as many as 10,000,000 particles strike the earth each day, while the lowest estimate puts the number at 7,500,000 per day. Many more of these particles strike the earth in the morning than at night, and frequently observing persons in their morning walks can plainly see evidences of the meteoric showers. These meteoric particles seem to be circulating in space, and the earth as it moves in its orbit strikes against them. Some of the meteoric showers are very copious and very bright. One writer has likened a meteoric shower that he saw to a snow-storm, the flakes being of fire instead of congealed vapor. Astronomical observers have detected, by means of the spectroscope, sodium, magnesium and sometimes iron in these bright shooting stars. One consequence of this constant falling of meteoric particles is that the earth is growing larger, but the lecturer said that there was no immediate danger of any radical change taking place in the surface of this sphere, for at the present rate of the meteoric fall, it would take 500,000,000 years for the earth to gain one inch of surface. Meteors are known to come in periodical showers, probably the most remarkable being the shower that occurs about the 11th or 12th of November. It appears that meteors follow in the track of comets. They are related to comets in some way or another, but exactly how the lecturer was not prepared to say. Some scientists thought that the meteors were the debris or cast-off particles of comets, while others thought that perhaps the comets were simply aggregations of meteoric particles, and the falling stars were the particles that did not get into the aggregations. It is certain, at any rate, that flocks of meteors follow the various comets at few millions of miles behind.

Comets, Prof. Young said, had always been puzzles to the astronomers and terrors to the superstitious. It had been seriously urged that comets were the forerunners of unhealthy and disastrous periods on the earth, but such beliefs had been vigorously ridiculed by scientists. The modern improvements in telescopes had caused a rapid increase in the number of discovered comets. These strange bodies are now being discovered at the rate of five or six every year. There are 650 comets in the catalogue at present, very few of which are bright ones, however. According to the most trustworthy astronomical statistics there were twenty-three bright comets between the years 1500 and 1600, twelve bright comets between 1600 and 1700, eight between 1700 and 1800, nine between 1800 and 1850, and since then there have been ten bright comets visible. The comets seen during the last few years were more or less remarkable. Astronomers become very enthusiastic in their search for comets. One ardent scientist bewailed the death of his wife a few years ago because the event lost him a comet, which a competitor happened to discover. There are about fifty comets that move in elliptical orbits. The theory is that each of these comets has been caught by some planet and held captive, being compelled to move around and around in

the same orbits continually. They appear to the people of the earth at stated periods; some have longer periods than others. Encke's comet has the shortest period, viz.: three and one-half years, while some comets have periods as long as thirty-three, forty and even seventy-five years. A view of the great comet of 1811 was shown on the screen. That was the largest comet ever known. The diameter of the head was not less than the diameter of the Sun. That comet never came within 100,000,000 miles of the earth, and yet it was a remarkable sight. Its tail was 60,000,000 or 70,000,000 miles in length. Prof. Young said that he had seen comets more than 50,000 miles in diameter running centrally over stars without dimming the stars in the slightest degree. It had been estimated that the mass of a large comet was equal to a lump of iron 100 miles in diameter, but the lecturer was inclined to doubt the correctness of that estimate. It had been clearly demonstrated that astronomical observers could see through the thickest part of a comet. Several views were exhibited to give the audience an idea of the different shapes and phases of comets. Biela's comet divided into two parts in 1842. The parts separated and gradually disappeared from view, and Prof. Young said that all that remained of them now was a shower of falling stars. The present comet was illustrated by various diagrams. One of the most remarkable things about this comet is the nearness of its approach to the Sun. It apparently almost scraped the solar surface. Moving at times with a velocity of 300 miles per second it had gone from one side of the Sun to the other inside of three hours. The comet of 1843 was very like the present comet. Its tail was about 100,000,000 miles in length, but it, too, succeeded in going from one side of the Sun to the other in three hours. The "whiskiness" of the tail of the comet of 1843 had caused much comment and discussion among astronomers. It was a matter of wonderment that a tail of so great length should be able to encircle the Sun in so short a time. Various different theories had been advanced on this point.

The office of comets in the planetary system is not known. Much has been written on the subject and many opinions have been advanced, but nobody can feel that a correct explanation of the use of these remarkably brilliant bodies has been given. It was suggested by Sir Isaac Newton that comets supplied the material for the preservation of light. Prof. Young did not know but that such might be the fact. It was an established fact that carbonic acid was an essential element of the atmosphere, and it was known that that element was disappearing. Who knows but that the comets are destined to supply the subtle influence needed to preserve the light with which the people of this globe are favored? The lecturer stated that he had received a letter which, he judged from the handwriting, must have come from a lady, asking whether there were inhabitants on the planets other than the earth. In reply, he desired to say that in point of actual fact the inquirer knew as much about the matter as he did. The only known planets that could possibly be inhabited by people such as dwelt on the earth were our nearest neighbors, Venus and Mars. It was possible that there were people, used to tropical climates on this planet, who could live on Venus.

There they would enjoy a perpetual summer. The lecturer thought it also likely that there might be some hardy Esquimaux who could manage to exist on the planet Mars. As for the other planets, if they were inhabited at all, they were inhabited by people of whom nothing was known, but who must necessarily be adapted to the peculiar qualities of the various planets.—*N. Y. Times.*

ENGINEERING.

TUNNELS IN GENERAL, AND THE ST. GOTHARD IN PARTICULAR.

Many curious things might be said about tunnels, old as well as new. For instance, the stupendous work—whose history links modern with ancient engineering—the object of which was to connect Lake Fucinus, now called Celano, with the Liris, now the river Gariglino, was undertaken 42 A. D. It took nearly eleven years to complete, and 30,000 men are said to have been engaged upon it. This subterranean canal was executed by order of the Emperor Claudius. For nearly eighteen centuries it seemed to have been forgotten; but on its discovery, about sixty years ago, the Neapolitan Government resolved to clear it out. This was accordingly done, but not until several years had been spent upon the task. The improved tunnel is four miles long; the original length was three miles. Prince Torlonia of Rome gradually bought up the shares, and carried on the operations at his expense until his death in 1871.

Modern tunneling—which by-the-way, is quite a distinct profession—is of three classes: First, tunneling through soft ground, such as clay, loose rock, etc. Second, rock-tunneling without machinery; Third, tunneling solid rock by the aid of machinery. In piercing a hill or other mass of earth, a large quantity of timber for temporary arching is required, until the brick or stone work has been provided. In some methods of tunnel-making it is judged more secure to brick the timber in. But this is very costly, especially when all the heavy timber has to be conveyed down a shaft or slope. Where the ground is rather yielding, and much water appears, an inverted arch is constructed across the bottom of the tunnel, so as to resist the pressure from beneath. There are now, however, other methods of construction in use. A new system has been devised of employing iron centers as a substitute for timber. Tunneling through loose rock, timbering, and then arching, is a method mostly in use in England and America; and where the length is comparatively short, hand labor is found cheaper than the employment of machinery. But at the present day, this kind of engineering is conducted on a vast scale with steel and diamond-pointed drills, driven by compressed air (at about forty pounds to the square inch), which latter serves for ventilation pur-

poses. In this way longer holes can be cut, and heavier charges of dynamite em ployed.

The first sub-aqueous tunnel in England was that under the Thames from Wapping to Rotherhithe, known as the Thames Tunnel. It was begun in 1807; the operations were stopped after a time; but recommenced by Sir M. I. Brunel, in 1825. The work was again interrupted by accidents; but the causeway was eventually opened for foot-passengers in 1843. In the year 1867 it was purchased by the East London Railway Company. It is 1,200 feet in length. Another subway is planned between the north side of the Thames and South Woolwich; it will be much deeper below the bed of the Thames than the older subway, and is to be constructed to admit of the transit of troops and war-material from Woolwich to the north side of the river, thus avoiding the circuitous route over London Bridge. Of this class we must also mention the Severn Tunnel, commenced in 1875, and now well on toward completion; but the bursting of a spring last year caused a serious interruption to the operations. The cutting has been mostly through rock, and about 100 yards in the centre of the channel yet remains unpierced.

Among other important works, the son of the eminent engineer above mentioned constructed Box Tunnel, on the Great Western Railway, in the vicinity of Bath; it is nearly four miles long. The Woodhead Tunnel, near Manchester, is three miles in length; a second cutting, of the same dimensions, was afterward made parallel with it, but separated by a longitudinal pier. The Kilsby Tunnel, on the London and Northwestern Railway, was four years in construction; it is 2,400 yards long, and cost £350,000; nearly four times the original estimate. Peculiar difficulties were encountered in making the Sydenham Tunnel (London, Chatham and Dover Railway). It is cut through the London clay, and while the works were in progress the clay commenced swelling and crushing the masonry. This was so serious that over 8,000 cubic yards of work had to be rebuilt.

Considerable progress is now being made with borings for the tunnel to be cut by the Mersey Railway Company under the bed of the Mersey. The shaft on the Birkenhead side has been sunk to a depth of about 120 feet with most satisfactory results. The boring is through the New Red Sandstone; on the Liverpool side, a depth of 100 feet has been reached. It is scarcely necessary to mention the tunnel which forms the chief feature of the Metropolitan (or Underground) Railway of London, opened January 10, 1863, and since extended in several directions. A similar work is projected for Paris, at an estimated cost of £6,000,000. There are now over eighty miles of tunneling in England.

Tunnels for portions of canal in hilly regions are sometimes of great length—such as the Canal de St. Quentin, more than seven miles long; the Huddersfield, and the Mauvages (Canal du Marne au Rhin), three miles each; Sapperton, Thames and Medway, Dudley, Blisworth, Soussey, Pouilly, ranging from two to four miles.

Transatlantic enterprise of this class has made great advances of late years. We select two or three out of nearly a score which deserve mention. The Hoosac

Tunnel was constructed to provide a direct route to the Hudson River. Until the cutting of this one, all rock tunneling in the United States was effected by hand-labor. It was commenced in 1858, and after several delays, arising from pecuniary difficulties and a serious accident in October 1867, it was finished in 1874. Under Lake Michigan there is a tunnel, or rather aqueduct, constructed to convey pure water to the city of Chicago This important work was begun in 1864, and completed in 1867; and a tunnel under the Hudson River at New York is progressing rapidly. In August, 1857, the celebrated Mont Cenis Tunnel—incorrectly so termed, because it is sixteen miles from that mountain, the tunnel actually passing under the Grand Vallon—was commenced by manual labor, and continued so to be worked until 1861, when rock-boring machinery came into use, in consequence of which rapid advances were made. The First Napoleon constructed a magnificent military road over Mont Cenis Pass, and this was used regularly by travelers. At length, when the French railways had crept close to one flank of the range, and Italian railways close to the other, plans for a railway tunnel to connect the two were formed. The French and Italian Governments agreed to share the cost between them. The tunnel is nearly eight miles long, and as much as 5,000 feet above the level of the sea. After working from opposite sides of the mountain, the workmen at length met in the centre, December 26, 1870. On the 17th of September in the following year the great undertaking was inaugurated in state, the ceremony being graced by the presence of the Empress Eugenie.

And now, in spite of the German prophecy, that "a large lake would be met with which would put a sudden end to all the work," we are able to record that on Sunday, February 29, 1880, the St. Gothard Tunnel, another gigantic effort of engineering, was accomplished. Thus for the second time have the hoary Alps been pierced through their very heart.

The St. Gothard, until the present century, had been one of the least frequented passes, although the hospital of the monks of St. Gothard was founded in 1331. In 1816, however, a regular post between five Swiss cantons and Milan was established; yet up to 1820 the path was only practicable for horses and pedestrians, and until lately the journey from Lucerne to Turin occupied twenty-five hours and a half, whereas the same journey henceforward will occupy but eight hours. The convention for the construction of this railroad was signed by Italy and Switzerland in 1869, and in 1870 the North German Confederation adhered to the convention. Engineer Gelpke and the geometrician, Koppe, were the chief designers. At first seven companies sent in their estimates—one Swiss, one Franco-Swiss, one Italian, one German, two English, one American. Finally L. Favre, of Geneva, and the Italian Society of Public Works in Turin, headed by Grattoni, the constructor of the tunnel through Mont Cenis, were the only competitors, and to Favre the contract was assigned, his offer being considered the most advantageous.

Meanwhile, the administration of the St. Gothard railway had arranged for the commencement of the excavations of the grand tunnel, begun in June, 1872.

For the perforation the waters of the Reuss were utilized on the northern slope; those of Val Tremola on the southern. In 1879, Favre, who directed all the works in person, died suddenly of apoplexy in the tunnel as he was explaining the operations to some foreign visitors; nor was he the only victim, 179 workmen having lost their lives by accidents or suffocation, while hundreds of others have contracted maladies which sooner or later will bring them to the grave.

The work which was never interrupted day or night, occupied nine years and three months—3,330 days in all. The first estimates of the sum total to be expended amounted to 227,000,000 francs, of which Italy agreed to pay 55,000,000, while various municipalities and provinces made up another 15,000,000; Germany and Switzerland contributed 63,000,000, the remainder of the sum being made up by shares, of which a vast number are held by Italians; so that in fact Italy has contributed far more than half of the sum total, the province and city of Milan alone furnishing 2,500,000.

The gallery of the St. Gothard runs in a straight line from the village of Göschenen to Albinengo, a village to the west of Airolo. The tunnel to be excavated along this line was 14,912 metres long, 2,700 metres longer than the gallery of Mont Cenis. In order to join it with the railroad which comes toward Airolo in an east-to-west direction, another gallery of 150 metres was excavated; in fact, between Göschenen and Brunnen there are twenty-seven galleries. The altitude at the entrance of the tunnel at Göschenen is 1,109 metres above the sea level; in the centre fifty metres higher, at Airolo forty metres higher. The geological formation differs essentially from that of the Cottian Alps. The bore of the gallery after some 2,000 metres of granite or granite-gneiss, entered into crystalline schist, intersected with veins of serpentine, a mass, in short, of the hardest rock, which at first threatened to baffle the perforating machines. The hydraulic works were also extremely tedious, owing to the difficulty of obtaining a sufficiently strong body of water from the Reuss, while, on the Airolo side, during the winter, avalanches often obstructed the bed of the tremola, rendering it necessary to excavate a bed under the snow. Signor Favre, in order to overcome the difficulty with the Reuss, constructed an enormous reservoir and a canal, while to baffle the avalanches he caused the water to be conducted by means of a wooden canal into the bed of a minor torrent, the Chiesso, less subject to avalanches. Other difficulties were encountered and overcome by his indomitable will, so that at his death it may be said that only the mechanical portion of the work remained.

This was completed really in 1881, but the inauguration was delayed, owing to various circumstances, until May 21, 1882. Then Italy, Germany, Switzerland, and we may say all Europe, participated with thorough satisfaction in the ceremonies attendant on the opening of the St. Gothard Tunnel; but, as is usually the case, the promoter, the initiator of that great international work has been almost entirely forgotten in his birthplace, Milan, as in his beloved Lugano, where he spent the last twenty years of his life in study and poverty, dying there in 1869. Cârlo Cattaneo, the greatest philosopher and political economist of

modern Italy, the guide and inspirer of the Five Days of Milan, in 1848, when the unarmed citizens defeated and drove out from their city the entire Austrian army under Radetsky, as early as 1859 insisted on the tunnel through the St. Gothard, in the interests of Italy and Switzerland alike.

It appears that, fearing injury to their traffic from Paris to Brindisi *via* the Mont Cenis, the French are now, in consequence of this new tunnel, boring through the Simplon—estimated at eleven and one-half miles in length—and "already there are rumors of schemes to bore through the Tarentaise and the Col du Mont; and even Mont Blanc is threatened with a tunnel," consequent upon the feverish competition likely to arise among the Swiss, German, French and Italian lines.

Five years ago, *La Nature* reported that in Spain an inter-continental railway company had been formed to carry out the scheme of connecting Europe and Africa by a tunnel under the Straits of Gibraltar, but nothing has been done in the matter.

But the bold idea of a tunnel under the British Channel will, if carried out, eclipse all former undertakings of this kind. The present "Channel Company" was formed in 1872; Sir John Hawkshaw, F.R.S., Mr. Brunlees and M. Gamond being appointed engineers. The route finally decided upon places the tunnel on a line extending from a spot between Folkestone and Dover, through the "Old Gray Chalk," to a point between Sangatte and Calais, on the opposite coast. The total length will be thirty-one miles, of which twenty-two will be under the Strait. Shafts are to be sunk on each shore to a depth of about 450 feet below high-water mark; and drift-ways from the bottom of these, for the draining of the tunnel, which is to begin 200 feet above the driftway. These driftways will be driven from both ends on a down gradient of one in eighty to the junction of the drainage driftway; and then on an up-grade of one in 2,640 to the middle of the Strait. The crown of the tunnel in all parts will be not less than 200 feet below the bed of the Dover Strait. It is hoped that the excavation will be mostly through chalk, in which case comparatively rapid progress will be made.

It has been estimated that the probable cost of this titanic task will be about $20,000,000; but Sir John Hawkshaw considers it best to double this estimate, in anticipation of greater obstacles which may arise. The preliminary works are now being prosecuted with great activity. A shaft has been sunk at Sangatte, to the depth of over 100 metres, and the experimental gallery has been commenced, and is to be continued for a kilometre—that is 3,250 feet—under the sea. The raising of the capital for the tunnel itself is, however, still a knotty problem; but if this can be accomplished, so much the better for all parties. As the passenger traffic between England and the continent amounts to nearly 400,000 annually, and is yearly on the increase, the opening of this marine subway will be of enormous public advantage.

BOOK NOTICES.

A STUDY OF THE MANUSCRIPT TROANO. By Cyrus Thomas, Ph.D.; Quarto, pp. 237. Illustrated. Government Printing Office, Washington, 1882.

This is a most thorough and comprehensive description and explanation of one of the three published Maya manuscripts which escaped destruction by the Spanish priests at the time of the conquest of Central America. It was named the Troano MSS., a compound of the two names of its former owner, Don Juan de Tro y Ortolano, by the Abbé Brasseur (de Bourbourg) who found it in his possession at Madrid in 1864. This valuable manuscript consists of thirty-five leaves or seventy pages written upon a kind of paper manufactured from the leaves of the maguey plant. The paper is in the shape of a strip, about fourteen feet long and nine inches wide, covered with a white paint or varnish and upon it the characters are painted in black, red, blue and brown. It is folded fan-like, into thirty-five folds, and presents the appearance, when closed, of an ordinary octavo volume. The hieroglyphics and figures cover both sides of the paper, the writing or painting having been executed apparently after the paper was folded, so that each page is distinctly legible.

As the Maya family was probably the most ancient and highly civilized on this continent, whether we judge by its traditions, records or architectural testimony, a careful and scholarly examination of its literary remains should be a most interesting and important study, and the perusal of the results of such an examination, prepared by a competent and enthusiastic investigator and a critical and attractive writer should be an extremely instructive and entertaining occupation. Such we find the works of Mr. Thomas, and such we believe will be the verdict of all other readers.

The introduction by Dr. Daniel G. Brinton is a dissertation upon thought and sound-writing in general, and the system of the Mayas in particular. It also comprises an account of the other Maya manuscripts as far as published.

The whole work is copiously illustrated and may be regarded as quite exhaustive. The contents are mainly as follows: The graphic system and records of the ancient Mayas, by Dr. D. G. Brinton; the manuscript and its characters, the Maya calendar, explanation of figures, etc. in the manuscript and the Dresden College; probable meaning of other figures; symbols, etc. that can be classed as written characters; the written characters in the manuscript; illustrations of the Day columns; a discussion of dates; inscriptions on the Palenque tablet. *Appendices:* extracts from Landa's "Relacion, etc.," quotation from Señor Melgar, translation of Tanda's description of festivals, mode of building houses among the Yucatees from Landa, manner of baptism in Yucatan, Landa.

KNIGHT'S NEW MECHANICAL DICTIONARY. Section III. Edward H. Knight, A. M. LL. D.; octavo, pp. 240. Houghton, Mifflin & Co., Boston; $2.00.

It is a fortunate thing for the subscribers to this valuable work that its author had fully completed it before his death, which occurred but a few weeks since, for we know of no one who could have successfully taken up and finished the task. As it is, the publication of the successive volumes will be slightly delayed —a few weeks at most, however—by reason of the proofs having to be read without the author's assistance.

The volume extends from the *monstrum horrendum* participle "Hydraulicking" which is the "short" among miners for washing down a placer claim by means of a hose or giant nozzle, to Printing Press, including descriptions of all kinds of hydraulic apparatus, ice machinery, laboratory apparatus, leather and its imitations, locomotives, magazine guns, marine engines, metallurgy, microscopes, mill machinery, mowers, nautical instruments, oil-stoves, oyster culture, pavements, phosphor bronze, photography, pile-drivers, plate machinery, pneumatic apparatus, porcelain manufacturing, portable engines, etc. Every page contains elaborate illustrations of the machines described, and with all the important titles are given references to full descriptions in other works. Thus, under the title "locomotive" more than three hundred references are made to articles upon various branches of the subject in the *Engineer*, *Scientific American*, *Manufacturer and Builder*, *Thurston's Vienna Reports*, *Van Nostrand's Magazine*, *Le Technologiste*, *Railroad Gazette*, etc.

It seems impossible to think of an appropriate subject that has been omitted and in most cases the treatment is full, clear and exhaustive. The printing and engravings are exceedingly well done.

THE THEORY OF THE GAS ENGINE. Dugald Clerk; 18mo., pp. 164; Illustrated. D. Van Nostrand, New York; 50c.

After pointing out the inefficiency of steam engines, the best of which do not credit more than ten per cent of the heat used by them into work and many of them not over four per cent, and the impracticability of gas engines, notwithstanding their apparent compliance with all necessary conditions, the author proceeds to show that the gas engine presents the best prospect of satisfactory results. He names three well defined types of engines that have been proposed.

1. An engine drawing into its cylinder gas and air at atmospheric pressure for a portion of its stroke, cutting off communication with the outer atmosphere, and immediately igniting the mixture, the piston being pushed forward by the pressure of the ignited gases during the remainder of its stroke. The in-stroke then discharges the products of combustion.

2. An engine in which a mixture of gas and air is drawn into a pump, and is discharged by the return stroke into a reservoir in a state of compression. From the reservoir the mixture enters into a cylinder, being ignited as it enters, without

rise in pressure, but simply increased in volume, and following the piston as it moves forward, the return stroke discharges the products of combustion.

3. An engine in which a mixture of gas and air is compressed or introduced under compression into a cylinder, or space at the end of a cylinder, and then ignited while the volume remains constant and the pressure rises. Under this pressure the piston moves forward, and the return stroke discharges the exhaust.

Several minor types have been proposed and many modifications of these three methods are used. A thorough understanding of these, however, renders it possible to judge the merits of any other.

Types 1 and 3 are explosion engines, the volume of the mixture remaining constant while the pressure increases. Type 2 is a gradual combustion engine in which the pressure is constant but the volume increases.

The author, in the course of his experiments on gas engines, has found that 1,537° Centigrade is the temperature usually attained by the ignited gases in his engine, and he has accordingly investigated the behaviour of air under different conditions at this temperature.

The results of his investigations are carefully and mathematically set forth in this volume which will at least be interesting to engineers and physicists.

THE USE OF TOBACCO. J. I. D. Hinds, Ph.D., Lebanon, Tenn.; 12mo., pp. 138. 55c. by mail.

Prof. Hinds is teacher of Chemistry in Cumberland University and has acquired a high standing as a chemist as well as teacher of natural science, in the South. His little work upon the Use of Tobacco gives evidence of his skill in both departments, since it not only furnishes a chemical analysis of the plant, but also gives its history, describes its botanical character and its physiological and pathological effects upon the system. He makes the statement that nearly nine hundred millions of the inhabitants of the globe are users of tobacco, and justly claims that an article that holds subject nine-fourteenths of the human race is certainly worthy of attention.

The chapter upon its physiological effects is largely made up of quotations from some of the best writers and thinkers of the day and is well worthy the careful perusal of all persons addicted to the use of "the weed." It is a very interesting and valuable monograph and should have a large distribution.

THE BREWER, DISTILLER AND WINE MANUFACTURER. Edited by John Gardner, F. C. S.; 12mo., pp. 278. Illustrated. P. Blakiston, Son & Co., Philadelphia, 1883. $1.75.

This is the first of a series of Technological Hand books designed to meet the wants and pockets of those who need practical information on special subjects and do not care to purchase cyclopædias or expensive technological works. It is intended to be equally valuable to the expert as to the beginner. This volume

gives full directions for the manufacturing of beers, spirits, wines, liquors, etc., and will be found convenient and useful to all, and indispensable to many, who are interested in the manufacture and sale of alcohol and its compounds. The next volume will be devoted to bleaching, dyeing and kindred subjects.

OTHER PUBLICATIONS RECEIVED.

Proceedings of the Biological Society of Washington, Vol. I, November, 1880, to May, 1882. Industrial Art in Schools, by Chas. G. Leland, of Philadelphia, being No. 6 of the Circulars of Information issued by the Bureau of Education. *Humboldt Library*, No. 41, Discussions in Current Science, by W. Mattieu Williams, F. R. A. S., F. C. S., 15c. The *Eclectic Magazine of Foreign Literature*, February, 1883, E. R. Pelton, Publisher, N. Y., Monthly, $5.00 per annum. Report on the Development of the Resources of Colorado for 1881-2, J. Alden Smith, State Geologist, 35c. The Forestry of the Mississippi Valley, Preliminary Report, by Hon. F. P. Baker, Topeka.

SCIENTIFIC MISCELL...

WHAT STATE GEOLOGICAL SURVEYS HAVE ACCOMPLISHED.

As a kind of appendix to Professor Trowbridge's article on the Missouri Geological Survey, in this number of the REVIEW, we have compiled a few items showing practically the results of such work in a few States.

The Missouri Geological Survey defined the boundaries of our coal fields, showing them to include three principal divisions, the Upper, the Middle and the Lower. The upper is barren; the lower productive and their limits are approximately laid down on the map. The map of coal fields with Report of 1872 gives the line between the upper, the lower and the middle measures. Only the geological surveys have accomplished this, for previously nothing was known.

Black slate is generally associated with coal. But there are also beds of black slate which do not belong to the coal formations. Such beds exist in New York, Pennsylvania, Ohio, and most of the Ohio Valley States and Missouri in a limited degree.

The Ohio survey saved thousands to the State by showing that these slates did not belong to the coal formation.

We have seen similar slates in Ralls County, Missouri, and have been where two shafts had been sunk upon them in search of coal. If a geologist had been previously consulted this expense could have been saved.

Ten or fifteen years ago Henry Engelmann, assistant Geologist of Illinois,

advanced the opinion that the Big Muddy coal of over four feet in thickness could be reached in a shaft at Centralia at a depth varying from 560 to 660 feet. Certain shafts were sunk, but not so deep, and no coal obtained; the parties at work several times stopped work but he continued to encourage them. Their efforts were finally crowned with success, coal was reached at 570 feet and six feet in thickness.

Gen. Pleasants, in charge of coal mining at Pottsville, Pa., had borings extended to 1,558 to a fourteen-foot seam of coal and 1,909 feet to a seventeen-foot seam. This was done to verify his theory, and the company, I understand, would or did appropriate $100,000 in works.

In 1874, Prof. G. C. Broadhead published Missouri Geological Report, over 700 pages with atlases. This report included certain coal producing counties of northeastern Missouri, with others rich in coal in the southwest. In each County Report approximate calculations were made of probable amount of coal in each township. Bates County was included in this Report. Within a few years thereafter the citizens of the county published a small paper giving extracts from the Report when the thickness of coal beds and quantity of coal was named. The paper in each instance gave credit to the Missouri Geological Report with the figures. This paper was circulated very widely. From that time to this the eyes of capitalists and railroad managers have been turned to Bates County.

In 1880 the Missouri Pacific Railroad was completed to the Bates County coal fields. The town of Rich Hill was started—now a thriving town of over 4,000 inhabitants with its hundreds of coal miners, two railroads and another in contemplation; zinc works put up also, and carloads of coal being continually carried off. (See statistics in January REVIEW).

In Michigan the prodigious results of the salt borings in the Saginaw district were the direct consequence of instructions given by the State Geologist before any intelligent work had been done there and after thousands of dollars had been wasted in ineffectual efforts around the edges of the great salt basin where the dilute brine was overflowing. In this instance the State Geologist not only pointed out out the different strata to be pierced ,but also the depth necessary to be bored in order to reach the vast body of salt from which the valueless springs derived their saline qualities. Within one year afterward 4,000 barrels of salt were produced, and within four years the production in the State was 2,678,598 barrels.

A few years ago Prof. Aughey prepared a monograph on the "Superficial Deposits of Nebraska," a hundred thousand of which were published in pamphlet form for gratituous distribution. These were circulated not only in the United States but also in Europe, and a year or more ago the railroad officials estimated that Prof. Aughey's little volume had brought a hundred thousand people to Nebraska.

THE WIGGINS STORM OF MARCH 9TH TO 11TH, 1883.

The President has received the following communication from Prof. E. Stone Wiggins, LL.D., Astronomer of the Canadian Finance Department, under date of Ottawa, November 25th:

On the 23rd of September last, I announced through the Canadian press that a great storm would occur in March next; that it would first be felt in the Northern Pacific; would appear in the Gulf of Mexico on the night of the 9th, and, being reflected by the Rocky Mountains, would cross this meridian from the west at noon, Sunday, March 11, 2883. No vessel, whatever her dimensions, will be safe out of the harbor, and none of small tonnage can hope to survive the tidal wave and fury of this tempest. As the wind will blow from the southeast, the planetary force will be sufficient to submerge the low lands of the American coast, especially those bordering on the Gulf of Mexico and washed by the Gulf Stream, where the air currents for several hundred miles along the east side of the Rocky Mountain Range, owing to great atmospheric pressure in those regions, will spread universal destruction. The New England States will also suffer severely from wind and floods. No point outside the harbor in the whole area of the Atlantic, especially north of the Equator, will be a place of safety. For this will be pre-eminently the greatest storm that has visited this continent since the days of your illustrious first President. In view of this event, therefore, I take the great liberty of representing to your Excellency the advisability of ordering all United States ships into safe harbors not later than the 5th of March, till this storm be passed.

THE KANSAS CITY ACADEMY OF SCIENCE.

About seven years ago the Kansas City Academy of Science was organized and has maintained a healthy and prosperous growth ever since. For nine months in each year, i. e. from September to May, it has monthly public meetings at which scientific papers by its members, usually of a popular character, are read and discussed. In addition to these entertainments, it has had several courses of public lectures, at which our citizens have been addressed by such eminent thinkers and speakers from a distance as Professors R. A. Proctor, W. I. Marshall, B. F. Mudge, Laws, Marvin, Swallow, Snow, Nipher, Lovewell, Broadhead and Robins; Doctors E. R. and I. D. Heath; Reverends Alexander Proctor, Richard Cordley and C. L. Thompson.

It has made an exploration of the Ancient Mounds of Clay County, as well as the interesting geological deposits of the carboniferous strata and the loess of this immediate vicinity. The Proceedings of this body when collected into volumes will be a valuable contribution to western science.

The Academy Library comprises about 300 volumes, principally U. S. Geo-

logical, Archæological, Astronomical and Smithsonian Reports, also Explorations, Surveys, Geological Reports from various States, besides monographs and pamphlets in large numbers. This library is now placed on the list of exchanges at the various departments in Washington and will receive as they are issued all of the most important publications of all of them.

Its cabinets now comprise nearly two thousand specimens of minerals, fossils and archæological relics, all of which are preserved at its rooms on the third floor of the Diamond Building at the junction of Main and Delaware Streets.

The present officers of the Kansas City Academy of Science, are Hon. R. T. VanHorn, President; W. H. Miller, Vice-President; Dr. R. W. Brown, Recording Secretary; Theo. S. Case, Corresponding Secretary, S. D. Bowker, M. D., Treasurer, and S. J. Hare, Curator and Librarian; Executive Committee, Hon. R. T. VanHorn, Prof. Geo. Halley, M. D., Prof. T. J. Eaton, M. D., Major B. M. Woodson, and Rev. J. D. Parker, U. S. A.

Its evenings for regular meetings are the last Tuesday of each month, except in Summer.

THE KANSAS CITY INSTITUTE.

This organization is now about one year old and has made a rapid and healthy growth under the management, mainly, of Judge E. P. West, its Curator. In addition to the ordinary work of scientific societies the Institute is paying attention to the cultivation of art in this community and has given two public exhibitions at which such specimens were among the chief attractions. At the exhibition of the collection in the Museum of the Kansas City Institute, on the evening of February 10th, the works of art were as follows:

Miss Vaughn, two paintings, namely—"Kansas City in 1867," and "Black-Hawk's Pulpit."

Mr. W. W. Findlay, four paintings, namely—"Conway Meadows," "Winter," "Summer," by Colby; and "Waldeinsamheit," by Langben.

Mr. Ruggles, nine paintings, namely—"Coast on Boston Bay," "Scene near Concord, N. H.," "Pueblo Indian Shepherd," "Mid-Ocean," three portraits taken from life and two fruit studies.

Mr. Campbell, four paintings, namely—"Beatrice," "Holy Family," after Raphael, "Portrait of Major Rollins," after Bingham, and "A Landscape."

Miss Vaughn and Mr. Campbell are well known in the city as artists of merit. Mr. Campbell is widely known in the East and maintains there a high reputation as a sculptor and designer. Mr. Ruggles is not so well known here, having been in the city less than seven months, but judging from his work on exhibition he will soon attain an enviable position among the artists of the country.

In Palæontology there were over 1200 upper coal measure fossils (our home formation) including specimens collected along the Missouri River from Omaha,

Nebraska, to Camden, Mo., and bones, teeth and fragments of the tusks of extinct mammals found in this county. The leg bone is now over forty inches. It must have been originally more than four feet; molar more than eleven inches across the crown longest diameter. One of the largest of the extinct mammals ever found.

Archæology. Shell beads and fish vertebræ found in vase in a mound at Weston, Mo., pottery and rough stone implements from "Old Fort," Saline Co., Mo., and other points along the Missouri River from Omaha, Neb., to St. Louis, Mo. Human bones found in Kansas City eighteen feet beneath the surface embedded in the loess. A fine meteorite, and two beautiful cases of minerals.

All of these were tastefully and appropriately arranged in the rooms of the Institute in the basement of the Unitarian Church on Baltimore Avenue, between 10th and 11th Streets.

The officers of the Kansas City Institute are as follows: President, Hon. A. Krekel, Judge U. S. District Court; Vice-President, Hon. Turner A. Gill, Circuit Court No. 1, Kansas City; Recording Secretary, Captain E. H. Webster; Corresponding Secretary, Warren Watson, Clerk U. S. District Court; Treasurer, J. S. Chick; Collector and Curator, Judge E. P. West.

WAS LORD BACON THE AUTHOR OF SHAKESPEARE'S PLAYS?

Mrs. Pott has lately published in England a book concerning Lord Bacon's Promus. The following notes reproduce its striking points:

The writer of the Preface is of the opinion that the similarities to Bacon in Shakespeare arise merely from the latter having borrowed from Bacon. Many attribute them to their having studied the same books. But this obliges us to believe that from these books two men so different derived identically the same theories and turns of expression, tastes, and antipathies. In looking at the Promus it really seems as if Bacon had been taking notes for Shakespeare. We find in it hundreds of notes of which no trace has been discovered in any of his own writings, or in those of any of his contemporaries except Shakespeare.

In almost every department of knowledge and opinion we have Bacon's mind in Shakespeare's writings.

In many cases we have identical forms of speech, words, and uses of words not found in previous or contemporary writers.

There are recorded in the Promus 203 English proverbs, of which no less than 150 are to be found in Shakespeare, while scarcely one of them is to be found in Bacon's own writings. Why would he have noted them if he had not intended to use them?

In one case we find two proverbs combined in the Promus and also in the plays, and yet they do not occur together in the book from which Bacon took them.

There are a few proverbs not in the Promus that are in Shakespeare, but these may be found in Bacon's letters and speeches.

There are 240 foreign proverbs in the Promus and 151 of them are also in the plays. It is hardly probable that Shakespeare had sufficient knowledge of French, Italian and Spanish to enable him to introduce them alone and adopt sentiments from them as if they were household words.

The frequent occurrence in the plays of the wise saws of the ancients leads to the conviction that they were not taken at first hand from the various classical authors, but from the commentaries of Erasmus, and there are 225 of these Erasmus notes in Shakespeare. And it is remarkable that they are not set down in the Promus in the order in which they occur in Erasmus, but are arranged as if for a purpose.

In the Promus occurs the adage, "To drive out a nail with a nail." This adage is introduced in "The Two Gentlemen of Verona" and also in "Coriolanus," and its setting in both pieces is so peculiar and Baconian as to be most remarkable. We see Bacon's strong tendency to use antithetical forms of speech and metaphors founded upon his scientific researches, and in both cases appears an original and erroneous scientific theory of Bacon's regarding heat. It is almost past belief that any two men should, at precisely the same period, have conceived the same theories and made the same mistakes.

The few Latin proverbs which were favorites of Bacon, and often quoted by him in letters and speeches (though not in the Promus) are all in Shakespeare.

One of his favorites Bacon does not use later than 1600; nor does it appear in any play of Shakespeare written after that time. Of 350 similes and metaphors in Bacon, 300 are found in Shakespeare.

In some of Bacon's letters, in which he discusses his writing by name, there is allusion to another class of writings which he calls "Works of creation," without describing them definitely. Sir Toby Matthew, to whom these letters were written, wrote to Bacon: "The most prodigious wit that ever I knew is of your name, though he be known by another."

Perhaps this does not prove that Bacon and Shakespeare were identical, but such evidence as it affords might suffice to hang a man if he were on trial for his life.—*Cor. N. Y. Sun.*

The popularity of the new Pulsometer Steam Pump is largely on the increase, both at home and abroad. The Company has just received an order from the Philadelphia & Reading Railroad for thirteen of its No. 8 pumps, 5-inch suction, 750 gallons per minute, to be used on its steam colliers for pumping water ballast. It is now working on orders received from South America, Cuba, and Mexico, for pumps of various sizes.—*Coal.*

EDITORIAL NOTES.

DR. EDWIN R. HEATH, the noted South American traveler and explorer whose addresses before the Kansas City Academy of Sciences and whose articles in the REVIEW have been received with so much pleasure and instruction by Kansas City audiences and readers, is now engaged in preparing accounts of his labors for the American Geographical Society and for *Harper's Monthly Magazine*.

CAPTAIN ANTHERNE of the British Steamer Stanmore, bears testimony to the value of oil upon a violent sea, having recently reached New York after a most stormy passage, during which every other expedient was resorted to ineffectually, and this with great success.

THE Linnæan Society, of New York, has just published the first volume of its Transactions in extremely attractive style, illustrated with a frontispiece portrait of Linnæas; Royal octavo, pp. 168, $3.00.

OWING to floods and other delays incident to winter, the *Atlantic*, *Harper*, and *Popular Science Monthly*, for March, and several other valuable exchanges were received too late for notice. Even a casual examination, however, shows them to be fully up to their usual standard of excellence.

THE total eclipse of the Sun which occurs on May 6th, will only be visible during its totality from two small islands in the Southern Pacific Ocean, named respectively Flint and Caroline. From these the totality of the eclipse will be seen to last almost five and one-half minutes, which is within one and one-half minutes of the greatest possible totality. For this reason it will be a most notable event, and astronomers from all quarters of the globe will visit these islands, probly more than doubling their present population, which is limited to about thirty souls.

REV. E. PEPPER, of Bradford, N. H., who is a regular reader of the REVIEW, writes to a friend in this city, "I find much in it that is fresh and interesting—improving—and a little that is characteristic of modern world-building. * * * * I have enjoyed most of the articles in the REVIEW. They are suggestive and instructive. The REVIEW is a sure indication that other things than money getting inspire the new West."

DR. D. G. BRINTON, of Philadelphia, announces the publication of a series of volumes to be known as the Library of Aboriginal American Literature, of which the following are the titles of those to appear first: The Chronicles of the Mayas, Central American Calendars, The Annals of Quanhtitlan, The Synod of the Creeks and the Chronicles of the Cakchiquels; $3 each volume.

PROF. E. STONE WIGGINS explains that the cause of his failure to correctly foretell a storm on February 9th, was that he "wrote down eight days eleven hours astronomical instead of calendar time which caused his storm to strike the western coast of America on the night of the 8th instead of the eastern

coast on the morning of the 9th, the Earth requiring seventeen hours more to turn the Atlantic toward the forces that were to generate the storm." He asks as a favor that "the movements of his great March storm be carefully watched," which will be surely done involuntarily if it is accompanied by the terrible disturbances he predicts. To enable our readers to grant the favor asked we publish elsewhere his letter to President Arthur, dated November 25, 1882.

CRYOLITE has been discovered of a fair quality in El Paso County, Colorado, near Pike's Peak. At present most of this mineral is brought from Greenland, and if future developments prove the Colorado discovery to be of any extent, it will be of considerable value to the manufactures in which it is employed.

CAPT. E. L. BERTHOUD, one of the valued contributors and friends of the REVIEW, has been elected one of the board of trustees of the Colorado State School of Mines.

A Microscopical Society was organized in Denver, on the 17th, with a number of charter members. Prof. S. H. Short, of the Denver University, was the principal originator of the Society.

ERNEST LE NEVE FOSTER has been appointed by the Governor as State Geologist of Colorado. The appointment meets with the hearty approval of the geologists of that State.

ITEMS FROM PERIODICALS.

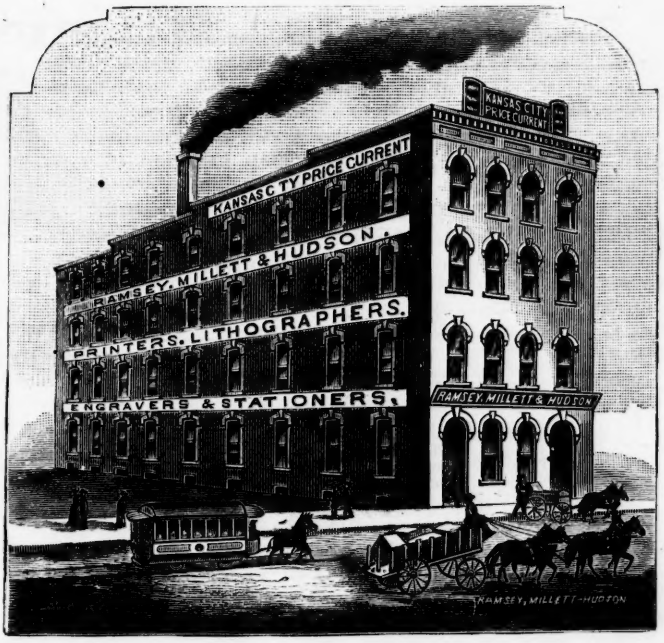
Subscribers to the REVIEW *can be furnished through this office with all the best magazines of the Country and Europe, at a discount of from 15 to 20 per cent off the retail price.*

IN the course of an extended notice of the REVIEW, the editor of the *Modern Argo* expresses the following flattering opinion: "The general scope and high character of this magazine places it on a level with the best of this kind of important and useful literature. It certainly is not only a credit to its editor and proprietor, but is also a publication that is an honor to Kansas City. The gauge of outside opinion is as often fixed by the character of the publications a community supports as by any other influence, and for this reason, even if for no other, Col. Case's magazine is worthy of the most liberal support. The REVIEW is now nearing its seventh volume and its progress in keeping up with modern thought and experiment in its domain is a matter for congratulation."

WE have received the first number of *Science*, the new weekly periodical to which we called attention in our last issue. It is an octavo of twenty-eight pages printed in double columns, and presents a very attractive appearance. Mr. Sam'l H. Scudder is the editor-in-chief, with several collaborators whose initials, as appended to their notes, are more or less familiar to the scientific reader. Among the contributors of original articles and critical notices of books are—Prof. S. P. Langley, Capt. Geo. E. Belknap, U. S. N., Samuel Kneeland, Prof. Asa Gray, and others. Under the circumstances of its origination, its able editorial force and its pecuniary backing it must certainly be a success and become one of the necessities of the professional and popular reader. We were, in view of our own short-comings, delighted, to detect even one typographical error in its columns. Cambridge, Mass.; $5.

THE *Acadian Scientist* kindly says, "The Kansas City REVIEW is the popular science monthly of the West, and seems to indicate to a large degree the spirit of enterprise that characterises our Western friends. We are always sure of finding its columns filled with able articles of scientific interest.

THE *American Naturalist* entered upon its seventeenth year with the January number and at the same time enlarged its dimensions by adding thirty pages of reading matter and taking in two new departments, Physiology and Psychology.



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THE *North American Review* for March opens with an article on "Money in Elections," by Henry George, who points out with admirable clearness one source of our political ills, and proposes a remedy that seems both eminently practicable and efficient. Robert S. Taylor writes of the "Subjugation of the Mississippi," a work which, in his opinion, and that of the Mississippi Commissi n, of which he is a member, can be accomplished only by employing, for the purpose of deepening and straightening the channel, the forces developed by the river itself. Moncure D. Conway contributes a very striking study of Gladstone as a man and a statesman, showing how even the more or less sinister moral and intellectual traits of his nature, quite as much as his pre-eminent native force and elevation of character, conspire to make him the foremost Englishman of his time. Hon. George W. Julian's "Railway Influence in the Land Office" is a grave, judicial exposure of the practices which, against the manifest intent of the law and the determinations of the highest courts, have won for corporations millions upon millions of acres of the public domain. Richard A. Proctor writes of the "Pyramid of Cheops;" Prof. Wm. G. Summer of "Protective Taxes and Wages;" Elizur Wright of "Some Aspects of Life Insurance;" and finally, there is a symposium on "Educational Needs," by Prof. G. Stanley Hall, Prof. Felix Adler, President Thomas Hunter, and Dr. Mary Putnam Jacobi.

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